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Release and Recovery of Introduced Parasites of the Alfalfa Weevil in Eastern North America

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CONTENTS

	Page
Purpose and scope.....	1
Descriptions of parasites.....	2
Established species.....	2
<i>Patasson luna</i> (Girault) (Mymaridae).....	2
<i>Bathyplectes anurus</i> (Thomson) (Ichneumonidae).....	2
<i>Bathyplectes curculionis</i> (Thomson) (Ichneumonidae).....	2
<i>Bathyplectes stenostigma</i> (Thomson) (Ichneumonidae).....	3
<i>Tetrastichus incertus</i> (Ratzeburg) (Eulophidae).....	3
<i>Microctonus colesi</i> Drea (Braconidae).....	4
<i>Microctonus aethiopoides</i> Loan (Braconidae).....	4
Species released but not recovered.....	5
<i>Peridesmia discus</i> (Walker) (Pteromalidae).....	5
<i>Trichomalus inops</i> (Walker) (Pteromalidae).....	5
<i>Dibrachoides dynastes</i> (Foerster) (Pteromalidae).....	5
<i>Necremnus leucarthros</i> (Nees) (Eulophidae).....	5
<i>Campogaster exigua</i> (Meigen) (Tachinidae).....	5
<i>Microctonus stelleri</i> Loan (Braconidae).....	6
Other parasitic organisms.....	6
Primary parasites.....	6
Secondary parasites.....	6
Methods for release and recovery.....	7
Making parasite releases.....	7
Sampling for recovery.....	7
Timing of collections.....	8
Rearing cages.....	8
A record of parasite liberations and recoveries.....	9
Table 1.—Species released and recovered in Eastern North America, 1957–75.....	9
Table 2.—Species released in Eastern North America but not recovered, 1957–75....	36
Appendix.....	39
Table 3.—Partial list of species released in the Western States and their origin, 1957–75.....	39
Maps.....	43

Release and Recovery of Introduced Parasites of the Alfalfa Weevil in Eastern North America

By RICHARD J. DYSART and WILLIAM H. DAY, *research entomologists, Beneficial Insects Research Laboratory,
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The alfalfa weevil (*Hypera postica* (Gyllenhal)), an introduced pest of European or Eurasian origin, was first detected in Utah in 1904. In 1951, a new invasion of this insect was discovered in Maryland, and this eastern population, hereinafter called "the eastern strain," has gradually moved into

all alfalfa-growing areas of Eastern North America. As a result of both infestations, the alfalfa weevil is now in all the 48 contiguous States and in 4 Canadian Provinces. It is considered to be the most important single pest of alfalfa in North America.

PURPOSE AND SCOPE

In 1957, personnel of the Beneficial Insects Research Laboratory at Moorestown, N.J. (now at Newark, Del.) began inoculative releases of imported parasites against the eastern strain of the alfalfa weevil. The objective of this biological control work is to distribute and establish the exotic natural enemies throughout the range of the eastern strain and thus reduce the weevil population to the approximate level that occurs in Europe. In cooperation with research workers in many States, thousands of releases and recoveries have been made of 13 parasite species in this massive and continuing program.

This publication has three sections. In the first is a brief account of each parasite or predator of the alfalfa weevil that has been established, liberated, or is known to occur in Eastern North America. These descriptions are arranged according to the host stage attacked. In the second are suggested methods for parasite releases and recovery attempts. In the third are listed all releases and recoveries¹ of introduced parasites on the

eastern strain of the alfalfa weevil from 1957 through 1975. In that respect this report is a revision of and a supplement to a previous publication.²

This report provides a detailed record of liberations and recoveries so that biocontrol workers will be able to relate colonization efforts in their particular States with those in the surrounding areas. We hope that the release data summarized here will encourage entomologists to search for parasite species that may be successfully established in their areas but that have not yet been recovered.

The geographical region of North America covered in this publication is east of longitude 100° W. The 100th meridian was selected because it approximates the point where the eastern and western strains of the weevil converged in 1971. Although the colonization of parasites on the western strain of the alfalfa weevil is beyond the scope of this report, we have listed in the appendix all western releases since 1957 where the parasites were supplied by the U.S. Department of Agriculture.

¹ In this report, "recovery" of a parasite species means that it has been collected in the field or reared or dissected from host material obtained from the release site or elsewhere at least 1 year after the release. Survival in the field for this length of time usually indicates that the species has become permanently established in a given area.

² BRUNSON, M. H., and COLES, L. W. THE INTRODUCTION, RELEASE, AND RECOVERY OF PARASITES OF THE ALFALFA WEEVIL IN EASTERN UNITED STATES. U.S. Dept. Agr. Prod. Res. Rpt. 101, 12 pp. 1968.

DESCRIPTIONS OF PARASITES

Established Species

All seven of the introduced and established natural enemies of the alfalfa weevil in Eastern North America are internal hymenopterous parasites of the egg, larva, or adult stage of the weevil. A brief account is given of the colonization, recovery, biology, and habits of each species. Unless otherwise noted, life-cycle data refer to the Middle Atlantic States. Parasitism figures cited are yearly averages for several locations and fields and are percentages of the *total*, not the peak, host population.

Patasson luna (Girault) (Mymaridae)

This species previously was placed in the genera *Mymar* and *Anaphoidea* and occasionally has been confused with *Anaphes pratensis* Foerster. *P. luna* was imported from Italy and released in Utah in 1911–13 and 1925–28. Material from France was also released in California in 1933–34. In all these introductions, *P. luna* apparently was mixed with *A. pratensis*. The latter was first recovered in 1926 in Utah, but *P. luna* was never recovered in the Western States until recently.³

In 1928, *A. pratensis* was shipped from Utah to Indiana for release against *Hypera nigrirostris* (F.), and *P. luna* might have been included in that material. Although there is no record of a release of *P. luna* in Eastern North America, in 1958 it was reared from alfalfa weevil eggs collected in Dutchess County, N.Y., by G. O. Poinar of Cornell University. Since then *P. luna* has been found at about 50 localities in the East (map 1) and is certainly more widely established than is now known.

The adult *P. luna* wasp is 1 mm long. The female deposits one to two eggs inside a weevil egg and may attack several eggs in a cluster within an alfalfa stem. There are several generations each year, and the parasite passes the winter inside the host egg. *P. luna* may have other hosts besides the alfalfa weevil. The data available suggest that parasitism by this species averages from 0 to 10 percent in overwintering eggs of the alfalfa weevil.

³ *P. luna* was reared from alfalfa weevil eggs collected in Cache County, Utah, in 1973 (D. W. Davis, Utah State University, pers. commun.).

Bathyplectes anurus (Thomson) (Ichneumonidae)

This species has also been referred to as *B. anura* and *B. corvina*. Specimens from Europe were released beginning in 1960, and the species was first recovered in New Jersey and Pennsylvania in 1964. The bulk of the introduced *B. anurus* was of French origin, although small numbers came from Sicily and the U.S.S.R. By 1966, field populations of *B. anurus* had increased sufficiently at certain release sites in New Jersey and Pennsylvania to permit collections for recolonization in other States. This work is continuing because the natural dispersion of *B. anurus* is slow. It is now well established in 17 Eastern States and in Ontario. Releases and recoveries of *B. anurus* are shown in maps 2 and 3.

The adult wasp is 3 mm long and has a black, robust body. There is one generation each year. The peak of parasitism occurs about a week before the peak in weevil larvae. The female parasite deposits an egg in the host larva; early instars are preferred. The egg hatches and the parasite larva feeds on the host, killing it after the weevil completes its cocoon. The parasite then spins a hard, brown, football-shaped cocoon, 2 mm in diameter by 3.5 mm long, which bears a raised, white, equatorial band. After formation of the cocoon, the parasite larva enters diapause.

The *B. anurus* larva has the unusual ability of causing its cocoon to "jump" several centimeters upward, a trait shared by few other ichneumonid parasites. This mobility increases the survival of *B. anurus* by enabling many cocoons to escape hyperparasites and unfavorable field conditions. The jumping cocoons can be found in plant debris in alfalfa fields.

In the fall the parasite larva pupates, becomes an adult, and diapauses within the cocoon until early the following spring.

In recent years from 6 to 37 percent of weevil larvae have been parasitized by this species in southeastern Pennsylvania and in central and northern New Jersey.

Bathyplectes curculionis (Thomson) (Ichneumonidae)

This parasite was successfully introduced from

Italy into Utah in 1911-13 and is now widely distributed in the Western States. In the Eastern United States, releases of *B. curculionis* from Utah were first made in 1953-55, but these efforts were not successful. In 1959, parasite material obtained from southern California was liberated in Delaware, New Jersey, and Virginia, and in 1960 the species was found to be established in these areas. Although the parental stock of the eastern *B. curculionis* population is predominantly of Italian origin via California, additional introductions have been made from France, Sweden, and the U.S.S.R. Since its establishment in the East, *B. curculionis* has been widely recolonized by biocontrol workers (map 4), but it has also spread naturally at a phenomenal rate.

It seems certain that this parasite accompanied the alfalfa weevil as it spread from the eastern seaboard into the Midwest and into Canada. *B. curculionis* has been recorded from more than 750 counties in the East (map 5), and it is probably in every area infested by the eastern strain of the weevil.

B. curculionis adults closely resemble those of *B. anurus*, but the female of *B. curculionis* has a longer ovipositor. There is one full generation in the spring, with a peak 1-2 weeks before the host peak, followed by a partial second generation 1-3 weeks after the host peak. Parasite adults are often collected in the summer and fall, especially in the Midwestern States, and these may be the result of a delayed second generation or a partial third or fourth generation.

The female parasite deposits an egg inside the weevil larva, preferring the early instars. The egg may be encapsulated by the host larva's defense reaction, but parasitism is often successful if superparasitism occurs or if the host larva is small when parasitized. Encapsulation of *B. curculionis* eggs by the host often seriously reduces the effectiveness of this parasite. None of the other established parasites are significantly affected. The surviving parasite egg hatches, the larva develops, and it eventually kills the host. The parasite larva then constructs its cocoon inside the weevil's cocoon like *B. anurus*. The cocoons of *B. curculionis* and *B. anurus* are similar in size and shape, but the white equatorial band of the former is not raised, and the cocoon may be either light brown and flexible (nondiapausing) or dark brown and hard (diapausing). The para-

site larva overwinters in the cocoon in the surface litter of alfalfa fields. In the past few years from 5 to 25 percent of weevil larvae have been successfully parasitized by *B. curculionis* in the Middle Atlantic States.

Bathyplectes stenostigma (Thomson) (Ichneumonidae)

This species has been referred to as *Bathyplectes* sp. "bagged," because the cocoon resembles a brown paper bag. It has also been referred to as *B. contracta*. Almost all the *B. stenostigma* released in North America were of Swedish origin; a few lots were from France. Liberations began in 1964, and large numbers were released at many localities in 1968 and 1969 (map 6). The species was first recovered in 1970, but it has been difficult to establish and has dispersed little. To date it has been recovered at only seven release sites in the East (map 7).

The adult parasite resembles the two previous species of *Bathyplectes*, except it is predominantly dark brown and the body is less robust. There is one generation per year, with the peak of parasitism occurring 1-2 weeks after the host larval peak. The female parasite lays an egg in a weevil larva. After hatching, the parasite larva develops, eventually killing the host before the latter spins a cocoon. Thus, the *B. stenostigma* cocoon, which is 3.8 mm long with no external white band, is constructed in the soil litter, where the parasite larva spends the winter in diapause. In a field near Hadley, Mass., during 1974 and 6 years after release, *B. stenostigma* parasitized over 7 percent of the total population of weevil larvae.

Tetrastichus incertus (Ratzeburg) (Eulophidae)

A few authors have called this species *T. erdoesi*. Releases of *T. incertus* began in 1960, and in 1962 it was found to be established in parts of Delaware, Maryland, New Jersey, and Pennsylvania. By 1964, field populations of *T. incertus* were being used as sources of recolonization in other States. Releases of this species are shown in map 8.

The established parasites were from a single locality in southern France; however, from 1967 to 1973, additional small introductions were made from Sweden, Romania, and Yugoslavia to enlarge the gene pool. The parasite dispersed very rapidly during the 1960's, but its movement has

greatly decreased in recent years. It is now present in 16 Eastern States and in Ontario and Quebec (map 9).

The adult is 1–1.5 mm long, black, compact rather than narrow and wasplike. There are three to four generations per year, with the largest populations in July–September. The female oviposits while astride a weevil larva, laying several eggs inside. From four to seven of the resulting parasite larvae complete development, killing the weevil larva after it has spun its cocoon. The parasites pupate within the empty skin of the host, which turns a mahogany brown and becomes brittle after the death of the host larva. Winter is spent in the prepupal stage within the host “mummy.”

During July, August, and September of 1965–69, *T. incertus* parasitized from 50 to 80 percent of weevil larvae in New Jersey and the surrounding States, but in recent years the species has been much less abundant. This is a direct result of the much lower levels of alfalfa weevil larvae, especially during the summer and fall. This in turn is a result of the pressure exerted by this and the other parasite species that are abundant in the Middle Atlantic region.

Microctonus colesi Drea (Braconidae)

Before it was named in 1968, this species was referred to as *Microctonus* sp. “black” or “domestic black.” It was first found in 1962 in southeastern Pennsylvania, although it had never been released. Since there is no evidence to suggest that *M. colesi* is native or had gained entrance prior to the alfalfa weevil, it is treated here as an introduced parasite. Probably it entered this country within the weevil. Because *M. colesi* is parthenogenic, establishment could have resulted from a small number of individuals. *M. colesi* is now known to be present in 13 Eastern States and appears to be moving slowly westward, considerably behind the weevil. Releases and recoveries of *M. colesi* are shown in maps 10 and 11.

The adult *M. colesi* is wasplike, 3 mm long, and entirely black. All individuals are female, and there is one generation per year. The period of oviposition roughly coincides with the larval peak of the alfalfa weevil. The egg is laid inside the weevil larva; the larger instars are preferred. After hatching, the first-instar larva enters dia-

pause and remains so while the host pupates and becomes an adult. The parasite larva overwinters within the adult weevil. During the following spring the parasite larva matures, kills the weevil, and spins a white cocoon in the soil litter. Since the fertility of weevils containing *M. colesi* larvae is much reduced in male weevils or eliminated in females, this effect is in addition to the ultimate mortality. From 1969 to 1973, *M. colesi* parasitized from 1 to 18 percent of the “new” (newly emerged, sexually immature) weevils in the Middle Atlantic region.

Microctonus aethioides Loan (Braconidae)

For many years this parasite has been referred to as *M. aethiops*; in fact, this name has been used in practically all the North American literature. Recently, however, Loan decided that the name *M. aethiops* had been misapplied, and he described the parasite discussed here as *M. aethioides*.⁴

This species was first released against the alfalfa weevil in 1957 and was found to be established in 1961 in New Jersey. All introduced parasites were from France. In 1963, field collections were begun in New Jersey for shipment to and release in other States. This recolonization has continued through 13 seasons. As a result of both recolonization and natural dispersal, *M. aethioides* is now present in 14 Eastern States and in Ontario (maps 12 and 13).

The adults are wasplike and 3 mm long; females are red brown and males are black. There are two generations per year. In the spring, about the time of the host larval peak, the female lays a single egg inside many of the “old,” overwintered sexually mature weevils. After hatching, the *M. aethioides* larva matures, issues from the dying host, and forms a white, silky cocoon, 4 mm long, in the soil litter. After pupation for 2–3 weeks, the adult parasite emerges from the cocoon. The female parasite oviposits in a “new” sexually immature adult weevil, and the resulting parasite larva diapauses and overwinters in the first instar within the weevil adult. Early the next spring the larvae of *M. aethioides* complete their development, spin cocoons, and transform to adults.

M. aethioides kills from 70 to 90 percent of the overwintered weevils in the Middle Atlantic

⁴ LOAN, C. C. A REVIEW OF HALIDAY SPECIES OF MICROCTONUS (HYM.: BRACONIDAE, EUPHORINAE). *Entomophaga* 20: 31–41. 1975.

States, and the second generation parasitizes an average of 7 to 39 percent of the new weevils. Even though the parasitized new weevils are not killed until the following spring, all the females and many of the males are rendered sterile, so the control impact is even more significant. Many biocontrol workers in the East consider *M. aethioides* the most important single species in the weevil parasite complex.

Species Released but not Recovered

Five of the species discussed here are small Hymenoptera and one is a tachinid fly. These insects were released in Eastern North America during 1957-72 but were never recovered. Possibly a few species are established in certain areas, because many releases have not been followed by surveys adequate for detection. It is hoped that the information provided here, plus the tables and maps, will encourage further searching for these species.

Peridesmia discus (Walker) (Pteromalidae)

This species, previously called *P. phytonomi*, was obtained in southern France and was released from 1959 through 1972. More than 45,000 adults were liberated in the East, mainly in the Southern States (map 14).

The adult is a black, compact wasp, 2 mm long. The female punctures the alfalfa stem with her ovipositor and lays an egg on the weevil egg mass. The larva feeds externally as a predator on the host eggs. Pupation occurs within the stem cavity. There are several generations per year, but because few weevil eggs are present in the summer and early fall, it is likely that *P. discus* passes this period in diapause or on an alternate host. The adults can live for many months and are very hardy. In southern France the adults oviposit in the field from November through January. Extensive surveys in France indicated that this predator was present in 6 percent of the overwintering egg masses.

Trichomalus inops (Walker) (Pteromalidae)

Ten releases were made of this species in the East from 1959 to 1970 (map 15). It was collected in France along with *P. discus*, but it was much less abundant. Both species are similar in size,

appearance, and life cycle as far as is known. In Europe *T. inops* is also thought to attack the eggs of *Apion* sp.

Dibrachoides dynastes (Foerster) (Pteromalidae)

This species has also been referred to as *D. druso*. From 1959 to 1964, over 13,000 *D. dynastes* adults of French origin were released at 28 localities in the Eastern States (map 16). The bulk of the released material was reared in the Moorestown laboratory. Although it has never been recovered in the East, in 1967 it was established in San Diego County, Calif., by entomologists of that State.

D. dynastes is a parasite of prepupae and pupae of the alfalfa weevil. The adult parasites are 2-3 mm long, with a metallic-green head and thorax. There are two generations per year in southern France, and the parasite apparently overwinters as an adult. Several eggs are laid on the host prepupa or pupa within its cocoon. After hatching, the parasite larvae feed externally on the body of the host. Usually three to five parasites reach maturity. In Europe this species also attacks other species of *Hypera*.

Necremnus leucarthros (Nees) (Eulophidae)

This species was released in 1965 at only two localities in New Jersey (map 17). About 300 adults of Italian origin were liberated at each site.

Like the preceding species, *N. leucarthros* is a gregarious ectoparasite of weevil prepupae. The adult parasites are 1.5-2.3 mm long and metallic green. The males possess branched antennae. In Europe *N. leucarthros* is widely distributed and attacks several species of Coleoptera, including other *Hypera*.

Campogaster exigua (Meigen) (Tachinidae)

During 1957, three small releases of this fly were made in Delaware and New Jersey (map 18). A total of 168 adults from France were liberated.

The adults are about 2.5 mm long and dark gray. The female does not lay eggs but deposits a first-instar larva on the thorax of the adult weevil. After penetrating the host, the parasite larva develops and finally forms a brownish puparium within the body of the weevil. The number of generations per year is not known; however, in the laboratory one complete generation requires

from 48 to 70 days. In Europe *C. exigua* also attacks several species of *Sitona*.

Microctonus stelleri Loan (Braconidae)

Before it was named in 1972, this species was referred to as *Microctonus* sp. "European black." From 1968 to 1970, over 4,100 adults obtained in France were released at 23 localities in the Eastern States (map 19).

The parasite has one generation per year, and its only known host is the alfalfa weevil. The females of *M. stelleri* and *M. colesi* are very similar in size and appearance. However, *M. colesi* is unisexual (all individuals are female), whereas *M. stelleri* has both sexes in about equal proportion. In the spring the mature parasite larva issues from the overwintered adult weevil and forms a white cocoon about 4 mm long in the ground litter. In about 2 weeks the adult parasite emerges, mates, and oviposits in larvae of the alfalfa weevil. It prefers larger instars. The parasite egg hatches, the first-instar larva enters diapause, and it remains so while the host pupates and becomes an adult. The *M. stelleri* larva overwinters within the adult weevil. Extensive collections in northern France during 1966-70 indicated that about 5.6 percent of the overwintering weevils were parasitized by *M. stelleri*.

Other Parasitic Organisms

Primary Parasites

Included here are various natural enemies that have been recorded from the eastern strain of the alfalfa weevil. These species are native to North America, and most of them attack a variety of other hosts. On the alfalfa weevil their control impact is almost always of minor significance. No doubt additional adventitious parasite species will be discovered.

Fidiobia rugosifrons Crawford (Platygastridae).—In 1972, adults of this species were reared from overwintering weevil eggs in Ontario. Curiously the parasite has not been recorded from weevil eggs at any other eastern site, although its type locality is in Pennsylvania.

Hexameris arvalis Poinar and Gyrisco (Mermithidae).—This nematode is most often found in fourth-instar weevil larvae, but pupae

and adults are also parasitized. A single weevil may contain from one to three nematodes. When mature, these nematodes are often more than 9 cm long. The weevil larvae die soon after issuance of the nematodes. This species has been reported from several other insect families.

Several adventitious parasites have been reared from weevil pupae at a few localities in the East: *Eriplanus micator* (Gravenhorst) (Ichneumonidae), *Helicobia rapax* (Walker) (Sarcophagidae), *Itoplectis conquisitor* (Say) (Ichneumonidae), *Pediobius* sp. (Eulophidae), and *Spilochalcis albifrons* (Walsh) (Chalcididae). The last species is usually a hyperparasite, attacking *Bathyplectes* cocoons. See discussion of secondary parasites.

Hyalomyodes triangulifer (Loew) (Tachinidae).—This fly is 3.5 mm long and has been reared from adult weevils collected in the field during the fall, winter, and spring. It is widely distributed in the East and parasitizes many species of adult Coleoptera. It has been recorded from the alfalfa weevil from New York to Georgia. After it issues from the dead host, the fly larva forms a small, brown puparium on the soil. The life cycle is probably similar to that of *Microctonus aethiopoides*. In certain eastern localities *H. triangulifer* has occasionally been found in as many as 5 percent of the weevils.

Leucostoma simplex (Fallén) (Tachinidae).—This fly was reared from an adult weevil collected in Dutchess County, N.Y. *L. simplex* is apparently Holarctic in distribution.

In addition, several diseases attack the alfalfa weevil. Microsporidian diseases, caused by species of *Nosema* and *Perezia*, are common in laboratory cultures, but they are rarely found in the field. Fungus diseases are also known. Those caused by species of *Beauveria* and *Entomophthora* are most frequently observed in nature. Epizootics caused by *E. phytonomi* Arthur have been reported in Ontario during the past few years.

Secondary Parasites

Members of this group, commonly known as hyperparasites, are not parasitic on the alfalfa weevil, but they attack the natural enemies of the weevil instead. They are discussed here only because they will be encountered in parasite impact studies and may be confused with the pri-

mary parasites. Competent identification is, therefore, necessary in such investigations.

Because *Bathyplectes* spp. spend many months in cocoons exposed on the soil, they are especially vulnerable to attack by secondary parasites. The following nine hymenopterous species have been reared from cocoons of *Bathyplectes* spp. in Eastern North America. This list does not include a few species that have been reared infrequently from *Bathyplectes*, and certainly additional hyperparasites will be recorded if there are more intensive field investigations.

Chalcididae.....	<i>Spilochalcis albifrons</i> (Walsh)
Eupelmidae.....	<i>Eupelmella vesicularis</i> (Retzius)
Ichneumonidae.....	<i>Gelis</i> sp.
Do.....	<i>Mesochorus agilis</i> Cresson
Pteromalidae.....	<i>Catolaccus aeneoviridis</i> (Girault)
Do.....	<i>Dibrachys cavus</i> (Walker)
Do.....	<i>Eupteromalus viridescens</i> (Walsh)
Do.....	<i>Sceptrothelys grandiclava</i> (Walker)
Do.....	<i>Sceptrothelys intermedia</i> Graham

All these species, except *M. agilis*, lay their eggs inside the *Bathyplectes* cocoon; *M. agilis* oviposits in weevil larvae previously parasitized by *Bathyplectes*. *S. albifrons*, *E. vesicularis*, *Gelis*

sp., *M. agilis*, and *C. aeneoviridis* are solitary parasites, i.e., only one adult is produced per *Bathyplectes* cocoon. *D. cavus*, *E. viridescens*, *S. grandiclava*, and *S. intermedia* are normally gregarious. Some unusual morphological features should be noted. Adults of *Gelis* sp. are always female and wingless, and females of *E. vesicularis* have greatly abbreviated wings. Adults of *S. albifrons* have conspicuously enlarged hind femora.

The mummies of *Tetrastichus incertus* remain on the soil for many months and, like cocoons of *Bathyplectes*, are particularly exposed to attack by hyperparasites. However, no secondaries are known to have been recorded from *T. incertus* mummies in this country. Similarly no hyperparasites have been recorded from cocoons of *Microctonus*, perhaps because they are in the soil litter for only a few weeks. However, the absence of hyperparasite records for these mummies and cocoons may only reflect the limited sampling efforts. On the other hand, we seriously doubt that hyperparasites will be found on the larval stages of *Microctonus* and *Tetrastichus* within their hosts, since none have ever been detected in extensive dissections and rearings over a 10-year period at this laboratory.

METHODS FOR RELEASE AND RECOVERY

Making Parasite Releases

Several requisites are critical for the successful establishment of parasites. The alfalfa field selected should have at least a moderate population of alfalfa weevils; the stage of the host should be appropriate (e.g., larvae for *T. incertus*); and insecticides should not be applied for at least 4 weeks or 1 year or more when possible. Previously mated females or mixtures of male and female parasites are suitable for release. The carton containing the parasites should be placed at the base of the alfalfa plants near the center of the field and opened slightly. If foliage is then arranged over the opening, the parasites will be less likely to disperse widely. After about 5 minutes the container can be examined, and the number and sex of the parasites that died in transit can be determined. It is imperative that parasites be released in the field as soon as possible after receipt.

After a parasite has become well established

at a release site, workers in some States have made recolonization releases within their States to accelerate parasite dispersal. Either parasitized hosts are collected and released directly in a different county, or the adult parasites are first obtained through rearing and then released. In certain States parasite recolonization efforts have been very successful.

Sampling for Recovery

We have found that the number of parasite species attacking the alfalfa weevil in a given area is frequently much greater than had been suspected. Careful surveys are required to determine whether a species has become established at a release site or whether parasites have dispersed from another area. Such surveys are based on (1) field collection of adult parasites, (2) dissection of field-collected hosts, or (3) rearing of parasites from field-collected hosts. Although the first two

methods are extremely useful, they require considerable experience on the part of the collector; they will not be discussed here.

The rearing method begins by collecting the appropriate host stage in the field at the right time. These hosts are placed in the proper type of cage in the laboratory and are provided with adequate food. This should result in parasite adults, cocoons, or mummies, which can then be identified.

Timing of Collections

Egg parasites.—All parasite species that feed internally in the egg or externally on the egg mass can be recovered whenever weevil eggs are present in the field, but the most profitable period is probably during the winter. Alfalfa stems containing weevil eggs should be cut in the field and taken to the laboratory for examination.

Larval parasites.—To provide estimates on timing that will be usable in different climatic regions, it is necessary to relate these estimates to a common biological reference point. The time of the host larval peak or maximum population density in the spring is used here for this purpose. In order to recover the following parasites, host larvae should be collected throughout the periods indicated: *Bathyplectes anurus*, 14 days prior to the host larval peak; *B. curculionis*, 14 days prior to and 14 days following the larval peak; *B. stenostigma*, from the larval peak to 21 days following the peak; *Tetrastichus incertus*, from the larval peak through the summer and fall if larvae are present.

Pupal parasites.—All species that attack the pupal stage of the alfalfa weevil can be recovered by collecting host cocoons whenever they are most abundant in the field. Depending on locality, this should be about 1–3 weeks after the host larval peak.

Adult parasites.—To recover any of the three species of *Microctonus*, host adults can be collected during midwinter or when they first appear in the spring. Probably the most profitable time to recover *M. aethiopoidea* from overwintered host adults is from the host larval peak to 21 days thereafter. *Hyalomyodes triangulifer* can be recovered at this time and also later in the season. In addition, certain workers have successfully used topical applications of synthetic hormones,

such as epoxyfarnesenic acid compounds, on new weevil adults to force emergence of parasites.

Rearing Cages

Egg parasites.—Alfalfa stems can be split to locate weevil egg masses. Eggs can be either left in place in short sections of stem or removed and incubated in small vials, capsules, or petri dishes. Moist filter paper or plaster-of-paris will maintain humidity. Recoveries also can be made by incubating bulk collections of alfalfa stems in darkened emergence chambers and collecting all adult insects attracted to a light source.

Larval parasites.—When attempting recovery of parasites, it is best to collect fourth-instar weevil larvae from the field. Such larvae will have been exposed to parasite attack for the longest time and will require a shorter rearing period in the laboratory. They can be reared in any plastic, wood, or cardboard cage if it (1) is ventilated with two screened side openings, (2) is constructed to prevent escape of the hosts and any parasites that emerge, and (3) contains fresh alfalfa bouquets as food. Another useful technique is to place larvae in large paper bags (up to 2,500 larvae per bag) with a quantity of alfalfa foliage. The bags are cut to a height of 25 cm and the tops left open for ventilation. Weevil larvae remain below with the foliage and do not escape from the bag. Small amounts of fresh alfalfa are added twice each day until the weevil larvae begin to spin cocoons. Then the tops of the bags are closed securely, and the bags are stored in a dry, well-ventilated area for several weeks, after which the parasite cocoons can be removed and counted.

Pupal parasites.—Species that emerge from the pupal stage can be recovered by collecting intact weevil cocoons from ground litter and the lower foliage in alfalfa fields. The host cocoons should be placed individually in small vials or gelatin capsules. By collecting and isolating weevil cocoons in this manner, investigators will obtain not only pupal parasites but many primary larval parasites and their secondaries as well. However, *Bathyplectes stenostigma* cannot be recovered by this method because it normally kills the host larva before the latter spins a cocoon.

Adult parasites.—To rear parasites from the adult weevil, best results are obtained when weevils are fed alfalfa bouquets in a small, venti-

lated cage with a false screen bottom of about 16 mesh per inch. The parasite larvae will issue from the weevils, pass through the screen, and pupate on the cage bottom under felt strips placed on absorbent paper. Parasite cocoons or puparia should be removed weekly without tearing the fragile cocoons and held in vials for emergence

of adults. Since the larva of *Campogaster exigua* forms its puparium within the body of the adult weevil, examination of the dead weevils in the cage would be necessary to detect it.

Parasites can be identified by sending the adults to the Systematic Entomology Laboratory, ARS, USDA, ARC-West, Beltsville, Md. 20705.

A RECORD OF PARASITE LIBERATIONS AND RECOVERIES

The seven parasite species presently established in Eastern North America are listed in table 1. Parasite release and recovery information is tabulated alphabetically by species, State, and county, and the locality or the name of the nearest town is given. The year of first recovery in a county is shown in the last column. Many of the releases in table 1 are recolonization releases made by various State workers. Where a parasite has been recovered in a particular State, release and recovery data are presented only on a county basis for that State. It is assumed that biocontrol workers will be able to find specific parasite populations within these counties for purposes of recolonization.

Many individual species have been recovered in counties where the parasite was never released. These records are, of course, the result of natural dispersion. Recoveries in a given field during the same season of release are not included here unless the recovery was made prior to the release. Therefore, the recovery records indicate that a species has survived at least one winter in the field.

The six species released in Eastern North America but not recovered are listed in table 2. As is often the case, the reasons for the failure of these parasites to become established are not known. Unfortunately, attempts to recover introduced species have varied greatly. In a few instances it is still too early to determine whether a species is successfully established or not.

The information on parasite liberations and recoveries has been collected from several sources, including release records on file at the Beneficial Insects Research Laboratory, release and recovery work by our laboratory staff, publications and proceedings of meetings and conferences, and inquiries to individual Federal and State workers. (See cooperators listed under Acknowledgment.)

Certain release information in tables 1 and 2 differs from that in Production Research Report 101, and the present data should be used.

A partial list of parasite releases in the Western States is in table 3 (Appendix).

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957–75*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Bathyplectes anurus</i>				
Alabama.....	Limestone.....	Belle Mina.....	70	-----
Delaware.....	Kent.....	-----	67, 70	75
	New Castle.....	-----	65, 67, 69	69
	Sussex.....	-----	69, 70	70
Illinois.....	Champaign.....	Urbana.....	69, 70	-----
	Pope.....	Robbs.....	67	-----
	Wabash.....	Kennsburg.....	68	-----

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,*¹ 1957–75—Con.

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Bathyplectes anurus</i> — Continued				
Indiana	Crawford			71
	Floyd			71
	Harrison		65	70
	Lawrence			71
	Tippecanoe		67	
	Washington			73
Iowa	Davis	Bloomfield	75	
	do	Pulaski	75	
	Ringgold	Diagonal	75	
Kansas	Geary	Ogden	75	
	Pottawatomie	Flush	74, 75	
	Reno	Hutchinson	74	
	Riley	Manhattan	74, 75	
Kentucky	Caldwell		74	
	Christian		71	
	Fayette		67	70
	Oldham		74	
Maryland	Allegany			75
	Baltimore			75
	Caroline			75
	Carroll			75
	Cecil			73
	Frederick			75
	Harford			73
	Howard		67	
	Kent			75
	Prince Georges			72
	Queen Annes			75
	Somerset			75
Massachusetts	Hampshire		67, 74	74
Michigan	Berrien		69	
	Cass		69, 70	
	Ingham		69	70
	Jackson		69, 70	
	Monroe		69	
Missouri	Boone		70	71
	Miller		71	
	Reynolds		65	
	St. Charles		71	
	Texas		71	
Nebraska	Dawson	Gothenburg	72, 74	
	do	Lexington	75	
	Lancaster	Lincoln	75	
	Lincoln	Gothenburg	72	
	Otoe	Dunbar	75	
	do	Paul	72	
	Saline	Crete	75	
	Saunders	Mead	74, 75	
New Hampshire	Hillsborough		67	73

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
New Jersey-----	Burlington-----		60, 63, 66	64
	Camden-----		66	-----
	Cumberland-----		66	75
	Gloucester-----		66	-----
	Hunterdon-----		65	-----
	Mercer-----		65	-----
	Middlesex-----		66	-----
	Monmouth-----		64, 65	69
	Ocean-----		-----	75
	Salem-----		65, 70, 71	72
	Somerset-----		66	69
	Sussex-----		-----	73
	Warren-----		71	72
New York-----	Cayuga-----		-----	70
	Dutchess-----		-----	75
	Franklin-----		74	-----
	Herkimer-----		71	72
	Orange-----		-----	73
	Tomkins-----		69	70
	Wayne-----		70	-----
North Carolina-----	Ashe-----		71	-----
	Rowan-----		71	72
	Wake-----		71	72
Ohio-----	Brown-----		72	-----
	Clark-----		74	-----
	Clinton-----		74, 75	75
	Erie-----		72	-----
	Franklin-----		65	-----
	Henry-----		75	-----
	Mahoning-----		74	-----
	Pickaway-----		71	-----
	Putnam-----		74, 75	-----
	Warren-----		71, 72, 75	72
	Wayne-----		65, 70, 71, 72	72
	Wood-----		75	-----
Oklahoma-----	Grady-----		74, 75	75
	Kiowa-----		75	-----
	Payne-----		72, 75	73
	Stephens-----		72	73
	Washita-----		75	-----
Pennsylvania-----	Berks-----		-----	67
	Carbon-----		-----	73
	Chester-----		64, 66, 68, 70	67
	Columbia-----		-----	73
	Cumberland-----		-----	70
	Dauphin-----		-----	71
	Delaware-----		-----	75
	Franklin-----		-----	75
	Fulton-----		-----	75

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Bathyplectes anurus</i> —				
Continued				
Pennsylvania—				
Continued				
	Huntingdon			75
	Lancaster		63	64
	Lebanon			70
	Lehigh			75
	Monroe			73
	Montgomery			70
	Northampton			70
	Perry			75
	Westmoreland			71
	York		68	73
South Carolina	Greenwood		72	
	Newberry		71	72
Tennessee	Cocke	Newport	71	
	Cumberland	Crossville	71, 72	
	Greene	Greeneville	71	
	Knox	Knoxville	67, 71	
	Marshall	Cornersville	71	
	Monroe	Vonore	71	
Texas	Burleson	Snook	71, 72	
	Kaufman	Peeltown	71	
	do	Rosser	72	
	Maverick	Eagle Pass	71, 72	
	Wharton	Iago	72	
	do	Lane City	71	
	Wilbarger	Vernon	71, 72	
	Zavala	Crystal City	71, 72	
Virginia	Accomack		72	
	Albemarle		71, 72	
	Alleghany		72	
	Amelia		70, 71, 73	71
	Amherst		72	
	Appomattox		72	
	Augusta		68, 72	
	Bath		72	
	Bedford		72, 73	
	Bland		72	
	Botetourt		71	
	Brunswick		71	
	Buchanan		72	73
	Buckingham		72	
	Campbell		72	
	Caroline		72	
	Carroll		72	
	Charles City		72	
	Charlotte		71	
	Chesterfield		72	
	Clarke		72	75

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Craig		72	
	Culpeper		71, 73	
	Cumberland		72	
	Dickenson		72	
	Dinwiddie		71	71
	Fairfax		72	
	Fauquier		71	
	Floyd		72	
	Fluvanna		72	
	Franklin		72	
	Frederick		72	
	Giles		72	
	Gloucester		72	
	Goochland		71	71
	Grayson		72	
	Greene		72	
	Halifax		71, 72	
	Hanover		70, 71, 72	71
	Henrico		72	
	Henry		72	
	Highland		72	
	Isle of Wight		72	
	James City		72	
	King and Queen		72	
	King George		72	
	King William		72	
	Lancaster		72	
	Lee		72	
	Loudoun		72	
	Louisa		71	
	Lunenburg		71	
	Madison		72	
	Mecklenburg		72	
	Middlesex		72	
	Montgomery		67, 72	68
	Nansemond		71	
	Nelson		72	
	New Kent		71	
	Newport News		72	
	Norfolk		72	
	Northampton		72, 73	
	Nottoway		71	71
	Orange		71	
	Page		72	
	Patrick		72	
	Pittsylvania		72	
	Powhatan		71, 73	71
	Prince Edward		72	
	Prince George		71	71
	Prince William		72	
	Pulaski		69, 71, 73	70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,*¹ 1957–75—Con.

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Bathyplectes anurus</i> —				
Continued				
Virginia—				
Continued				
	Rappahannock		71	-----
	Richmond		72	-----
	Roanoke		72	-----
	Rockbridge		72	-----
	Rockingham		72, 73	-----
	Russell		72, 73	-----
	Scott		72	-----
	Shenandoah		72	-----
	Smyth		72	-----
	Southampton		71, 72, 73	-----
	Spotsylvania		71	-----
	Stafford		71	-----
	Tazewell		72	-----
	Warren		72	-----
	Washington		72	-----
	Westmoreland		72	-----
	Wise		72	-----
	Wythe		71	-----
West Virginia	Berkeley		70, 74	-----
	Brooke		75	-----
	Grant		74	-----
	Hampshire		74	-----
	Hancock		75	-----
	Hardy		71, 74	72
	Jackson		75	-----
	Jefferson		71, 74	72
	Marshall		75	-----
	Mason		70, 71	72
	Mineral		74	-----
	Monongalia		73	-----
	Morgan		74	-----
	Ohio		75	-----
	Pleasants		75	-----
	Preston		70	71
	Wood		75	-----
Wisconsin	Columbia	Leeds	74	-----
	Dane	Mt. Horeb	71	-----
	do	Oregon	74	-----
	Kenosha	Erly	69	-----
	Rock	Beloit	70	-----
Canada (Ontario)	Prince Edward		70	71
	Welland		70	-----
<i>Bathyplectes curculionis</i> ²				
<i>Bathyplectes stenostigma</i> ³				
Delaware	New Castle	Newark	69	⁴ 70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957–75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Sussex	Milton	69	-----
Illinois	Champaign	Urbana	69	-----
Indiana	Kosciusko	Pierceton	68	-----
	Tippecanoe	Lafayette	68	-----
Kentucky	Fayette	Lexington	69	-----
Maryland	Frederick	Frederick	68	-----
Massachusetts	Hampshire	Hadley	68	71
Michigan	Berrien	Three Oaks	69	-----
	Cass	Howard T.	69	-----
	do	Milton T.	68	-----
	do	Pokagon T.	69	-----
	Kalamazoo	Gull Lake	69	-----
New Hampshire	Merrimack	Concord	68	70
New Jersey	Burlington	Moorestown	67, 68	-----
	do	Rancocas	68	-----
	Salem	Alloway	69	-----
	Somerset	Griggstown	68	-----
	Sussex	Newton	69	-----
	Warren	Washington	68	-----
New York	Herkimer	Mohawk	70	71
	Livingston	Dansville	73	-----
	Madison	Sheds	68	-----
	Tompkins	Ithaca	69, 71	72
	do	S. Lansing	72	-----
Ohio	Pickaway	S. Bloomfield	70	-----
	Wayne	Wooster	68, 70	⁴ 72
	Wood	Bowling Green	68	-----
Pennsylvania	Bradford	Wysox	68	-----
	Franklin	Sylvan	69	-----
	Lancaster	Bowmansville	69	-----
	do	Christiana	64	-----
	Northampton	Martins Creek	69	-----
	Somerset	Brotherton	68	-----
Vermont	Addison	Shoreham	68	-----
	Chittenden	Shelburne	68	-----
Virginia	Charlotte	Charlotte C.H.	69	-----
	Montgomery	Elliston	68	-----
Wisconsin	Kenosha	Pleasant Prairie	69	-----
	Rock	Beloit	70	-----
Canada (Ontario)	Prince Edward	S. Bay	70	⁴ 71
<i>Microctonus aethioides</i> ⁵				
Arkansas	Craighead	Monette	67	-----
	Mississippi	Keiser	66	-----
Connecticut	Tolland			69
Delaware	Kent		67	68
	New Castle		65	67
	Sussex			69
Illinois	Champaign	Homer	68	-----
	do	Urbana	70	-----

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Microctonus aethiopoides</i> ⁵ —				
Continued				
Illinois—				
Continued				
	Clark	Casey	66	-----
	Coles	Lerna	66	-----
	Crawford	Palestine	67	-----
	Cumberland	Neoga	66	-----
	Gallatin	Equality	67	-----
	Johnson	Vienna	65	-----
	Montgomery	Taylor Springs	68	-----
Indiana	Dubois	Dubois	66	-----
	Floyd	New Albany	65	-----
	Harrison	Laconia	67	-----
	Knox	Vincennes	68	-----
	La Porte	(?)	74	-----
	Tippecanoe	Klondike	68	-----
	do	Lafayette	67	-----
Iowa	Lee	Ft. Madison	75	-----
Kansas	Clark	Ashland	75	-----
	Riley	Manhattan	73, 74	-----
Kentucky	Bourbon	N. Middletown	71	-----
	Fayette	Lexington	64, 67, 69, 71	-----
	Lincoln	Hustonville	68	-----
Maine	Cumberland	Westbrook	69	-----
Maryland	Allegany		70, 71	-----
	Baltimore		70, 71	71
	Caroline			70
	Cecil			70
	Frederick			69
	Harford			70
	Howard		70	72
	Kent			70
	Montgomery		70	70
	Prince Georges		65, 66, 68	70
	Queen Annes			70
	Somerset			72
	Washington		70	70
Massachusetts	Berkshire			70
	Franklin		67	70
	Hampshire		65, 68	70
Michigan	Allegan			73
	Arenac		73	75
	Barry			73
	Benzie			75
	Berrien		73	-----
	Branch		73	75
	Calhoun			73
	Cass		68, 73, 74	70
	Clinton		73, 74	75
	Eaton			73

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957–75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Hillsdale		73	
	Ingham		70, 73, 74	72
	Ionia		73	75
	Isabella		73	75
	Jackson		69	70
	Kalamazoo		69, 73	70
	Kent		73	
	Lake		74	75
	Lapeer		73	75
	Lenawee		68, 73	75
	Livingston		73, 74	75
	Manistee			75
	Mason		74	75
	Mecosta		73	75
	Missaukee		70, 71, 72	75
	Monroe		73, 74	75
	Montcalm		73	75
	Muskegon		73	
	Newaygo		73	75
	Oceana		74	75
	Osceola		73	75
	Oscoda			75
	Ottawa		73	
	Saginaw		73	75
	St. Clair		73	
	Sanilac		73, 74	75
	Shiawassee		73, 74	75
	Tuscola		70	72
	Washtenaw		73, 74	75
Minnesota	Houston	Freeburg	71	
Mississippi	Oktibbeha	Starkville	75	
Missouri	Boone	Columbia	70, 73	
	Cape Girardeau	Gordonville	67	
	Grundy	(?)	71	
Nebraska	Dawson	Gothenburg	72, 73, 74	
	Lincoln	do	72	
	Otoe	Dunbar	74	
	Saline	Milford	74	
	Saunders	Mead	74	
New Hampshire	Cheshire			73
	Grafton		67	
	Hillsborough		68	73
	Merrimack		66	
	Strafford		66	68
New Jersey	Bergen			71
	Burlington		57, 58, 59, 60, 65	61
	Camden			69
	Cumberland			66
	Gloucester		63	65
	Hunterdon		60, 65	61

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Microtonus aethioides</i> ⁵ —				
Continued				
New Jersey—				
Continued				
	Mercer	.....	65	67
	Middlesex	.....		69
	Monmouth	.....	65	65
	Morris	.....		69
	Ocean	.....		75
	Passaic	.....	65	.....
	Salem	.....	65	69
	Somerset	.....	62	64
	Sussex	.....		68
	Warren	.....	62, 65, 67	68
New York	Allegany	.....	74	.....
	Broome	.....		71
	Cattaraugus	.....	72, 74	.....
	Cayuga	.....	68	70
	Chautauqua	.....	72, 74	.....
	Chemung	.....		73
	Chenango	.....		71
	Clinton	.....	70	71
	Columbia	.....		70
	Cortland	.....	71	73
	Delaware	.....		70
	Dutchess	.....		70
	Erie	.....	74	.....
	Franklin	.....	71, 74	.....
	Fulton	.....		71
	Genesee	.....	72, 74	.....
	Herkimer	.....	68	70
	Jefferson	.....	73	74
	Lewis	.....		71
	Livingston	.....	71, 72, 74	72
	Madison	.....		69
	Monroe	.....	74	74
	Montgomery	.....		71
	Niagara	.....	71, 72, 74	.....
	Oneida	.....		74
	Onondaga	.....		72
	Ontario	.....	71, 73, 74	74
	Orange	.....		69
	Orleans	.....	74	.....
	Oswego	.....	70	73
	Otsego	.....		70
	Rensselaer	.....		70
	St. Lawrence	.....	72, 74	73
	Saratoga	.....		75
	Schoharie	.....		70
	Schuyler	.....		73
	Seneca	.....	71, 72	73

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
North Carolina	Steuben		71, 74	71
	Tioga		65, 66	70
	Tompkins		68, 71	70
	Ulster		68	69
	Washington			75
	Wayne		73	74
	Wyoming		72, 74	
	Yates		72	73
	Rowan	Salisbury	66	
	Wake	Raleigh	63	
Ohio	Auglaize			75
	Clark		74	75
	Clinton		73, 75	74
	Coshocton		70	
	Erie		71	
	Guernsey		70	
	Hancock			75
	Henry			75
	Meigs		65	
	Putnam		73, 74	75
	Sandusky			75
	Seneca			75
	Shelby		70	
	Warren		72	
	Wayne		68, 70, 71, 72, 73, 75	73
	Wood		75	75
	Wyandot			75
Oklahoma	Payne	Stillwater	73	
	Stephens	Duncan	73	
Pennsylvania	Bedford		70	71
	Berks			68
	Bradford		68	69
	Bucks			69
	Butler		70	
	Centre		65	69
	Chester		66	68
	Columbia			73
	Cumberland		65	
	Dauphin		65	68
	Delaware			75
	Franklin		70	71
	Fulton			75
	Huntingdon			75
	Jefferson			72
	Lancaster		64, 65	68
	Lebanon			72
	Lehigh			70
	Luzerne			73
	Monroe			69
	Montour			73
	Northampton			69

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Microctonus aethiopoides</i> ⁵ —				
Continued				
Pennsylvania—				
Continued				
	Northumberland			73
	Perry			75
	Washington		70, 71	
	Westmoreland		70	71
	York			73
Rhode Island	Washington			73
Tennessee	Cumberland	Crossville	71	
	Knox	Knoxville	66, 67, 68	
	Marshall	Lewisburg	66	
Texas	Burleson	College Station	72	
Vermont	Addison		65, 66, 67	70
	Bennington			73
	Chittenden		68	69
	Grand Isle		68	69
	Washington			71
	Windham			73
Virginia	Accomack		72	
	Albemarle		72	
	Alleghany		72	
	Amelia		71, 73	
	Amherst		72	
	Appomattox		72	
	Augusta		72	
	Bath		72	
	Bedford		72, 73	
	Bland		72	
	Botetourt		71	
	Brunswick		71	
	Buchanan		72	
	Buckingham		72	
	Campbell		72	
	Caroline		72	
	Carroll		72	
	Charles City		72	
	Charlotte		71	
	Chesterfield		72	
	Clarke		72	75
	Craig		72	
	Culpeper		71, 73	
	Cumberland		72	
	Dickenson		72	
	Dinwiddie		71	
	Fairfax		72	
	Fauquier		71	
	Floyd		72	
	Fluvanna		72	

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957–75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Franklin	-----	72	-----
	Frederick	-----	72	-----
	Giles	-----	72	-----
	Gloucester	-----	72	-----
	Goochland	-----	71	-----
	Grayson	-----	72	-----
	Greene	-----	72	-----
	Halifax	-----	72	-----
	Hanover	-----	67, 69, 71, 72	68
	Henrico	-----	72	-----
	Henry	-----	72	-----
	Highland	-----	72	-----
	Isle of Wight	-----	72	-----
	James City	-----	72	-----
	King and Queen	-----	72	-----
	King George	-----	72	-----
	King William	-----	72	-----
	Lancaster	-----	72	-----
	Lee	-----	72	-----
	Loudoun	-----	72	-----
	Louisa	-----	71	-----
	Lunenburg	-----	71	-----
	Madison	-----	72	-----
	Mecklenburg	-----	72	-----
	Middlesex	-----	72	-----
	Montgomery	-----	65, 67, 72	73
	Nansemond	-----	71	-----
	Nelson	-----	72	-----
	New Kent	-----	71	71
	Newport News	-----	72	-----
	Norfolk	-----	72	-----
	Northampton	-----	72, 73	-----
	Nottoway	-----	71	-----
	Orange	-----	71	-----
	Page	-----	72	-----
	Patrick	-----	72	-----
	Pittsylvania	-----	72	-----
	Powhatan	-----	71, 73	71
	Prince Edward	-----	72	-----
	Prince George	-----	71	-----
	Prince William	-----	72	-----
	Pulaski	-----	69, 71, 73	72
	Rappahannock	-----	71	-----
	Richmond	-----	72	-----
	Roanoke	-----	72	-----
	Rockbridge	-----	72	-----
	Rockingham	-----	72, 73	-----
	Russell	-----	72, 73	-----
	Scott	-----	72	-----
	Shenandoah	-----	72	-----

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Microctonus aethiopoides</i> ⁵ —				
Continued				
Virginia—				
Continued				
	Smyth		72	
	Southampton		71, 72, 73	
	Spotsylvania		71	
	Stafford		71	
	Tazewell		72	
	Warren		72	
	Washington		72	
	Westmoreland		72	
	Wise		72	
	Wythe		71	
West Virginia	Berkeley			73
	Marshall		73	
	Monongalia		73	
	Preston		71, 72, 73	
Wisconsin	Columbia	Arlington	73	
	Dane	Mt. Horeb	71	
	Kenosha	Erly	69	
	Rock	Beloit	70	
	Sauk	Sauk City	72	
Canada (Ontario)	Brant		71	
	Dundas		71	
	Durham		71	
	Elgin		70, 71	72
	Frontenac		71	
	Glengarry		71	
	Grenville		71	
	Haldimand		70, 71	71
	Halton		71	72
	Hastings		71	
	Kent		70	71
	Lambton		71	
	Lanark		71	
	Leeds		71	
	Lincoln		71	
	Middlesex		71	
	Norfolk		71	
	Oxford		71	
	Peel		71	
	Perth		71	
	Prince Edward		70	72
	Welland		71	72
	Wellington		71	
	York		71	
<i>Microctonus colesi</i> ⁶				
Connecticut	Tolland			67
	Windham			67

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
Delaware.....	Kent.....			62
	New Castle.....			62
	Sussex.....			70
Illinois.....	Champaign.....	Ivesdale.....	67	
	do.....	Urbana.....	69, 70	
	Cumberland.....	Roslyn.....	68	
	De Witt.....	Clinton.....	68	
	Douglas.....	Camargo.....	67	
	do.....	Hindsboro.....	68	
	Madison.....	Alhambra.....	68	
	Washington.....	New Minden.....	67	
Indiana.....	Boone.....	Thorntown.....	67	
	Montgomery.....	Waynetown.....	67	
Kentucky.....	Fayette.....	Lexington.....	70	
Maryland.....	Allegany.....			70
	Anne Arundel.....			71
	Baltimore.....			71
	Carroll.....			67
	Cecil.....			62
	Dorchester.....			71
	Frederick.....			67
	Garrett.....			71
	Harford.....			69
	Howard.....			66
	Montgomery.....			66
	Prince Georges.....		68	66
	Queen Annes.....			71
	Washington.....			67
Massachusetts.....	Berkshire.....			70
Michigan.....	Berrien.....	Three Oaks.....	69	
	Cass.....	Howard T.....	69	
	Jackson.....	Springport.....	69	
New Jersey.....	Burlington.....			63
	Cumberland.....			66
	Gloucester.....			70
	Hunterdon.....			67
	Mercer.....			67
	Monmouth.....			64
	Morris.....			69
	Ocean.....			75
	Salem.....			69
	Somerset.....			63
	Sussex.....			69
	Warren.....			63
New York.....	Cayuga.....			71
	Columbia.....			70
	Dutchess.....			70
	Fulton.....			72
	Livingston.....			73
	Madison.....			72
	Orange.....			73
	Rensselaer.....			72

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Microctonus colesi</i> ⁶ —				
Continued				
New York—				
Continued				
	Schuyler			73
	Tompkins			71
	Ulster			72
North Carolina	Rowan			70
	Wake			67
Ohio	Belmont			70
	Brown		72	
	Clark		74	
	Clinton		74	
	Delaware			75
	Erie		70	
	Franklin			73
	Guernsey			71
	Hancock			74
	Logan		70	
	Meigs			72
	Ottawa		70	
	Putnam		73, 74	
	Seneca		70	
	Shelby		70	
	Union		70	75
	Warren		72, 73, 75	
	Washington			71
	Wayne			71
	Wood		75	
Pennsylvania	Bedford			71
	Berks			67
	Bradford			72
	Bucks			63
	Butler			71
	Centre			70
	Chester			62
	Clarion			71
	Cumberland			71
	Dauphin			71
	Franklin			71
	Huntingdon			72
	Jefferson			71
	Lancaster			65
	Lebanon			71
	Luzerne			73
	Mercer			71
	Monroe			70
	Montour			71
	Northampton			70
	Northumberland			71
	Pike			73
	Snyder			71

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Somerset	-----		69
	Union	-----		71
	Washington	-----		72
	Westmoreland	-----		71
	York	-----		71
Rhode Island	Washington	-----		73
Vermont	Bennington	-----		72
Virginia	Accomack	-----	72	-----
	Albemarle	-----	72	-----
	Alleghany	-----	72	-----
	Amelia	-----	73	-----
	Amherst	-----	72	-----
	Appomattox	-----	72	-----
	Augusta	-----	72	73
	Bath	-----	72	-----
	Bedford	-----	72, 73	-----
	Bland	-----	72	-----
	Buchanan	-----	72	-----
	Buckingham	-----	72	-----
	Campbell	-----	72	-----
	Caroline	-----	72	-----
	Carroll	-----	72	-----
	Charles City	-----	72	-----
	Charlotte	-----		73
	Chesterfield	-----	72	-----
	Clarke	-----	72	70
	Craig	-----	72	-----
	Culpeper	-----	73	-----
	Cumberland	-----	72	-----
	Dickenson	-----	72	-----
	Dinwiddie	-----	71	71
	Fairfax	-----	72	-----
	Floyd	-----	72	-----
	Fluvanna	-----	72	-----
	Franklin	-----	72	-----
	Frederick	-----	72	70
	Giles	-----	72	-----
	Gloucester	-----	72	-----
	Grayson	-----	72	-----
	Greene	-----	72	-----
	Halifax	-----	72	-----
	Hanover	-----	71, 72	71
	Henrico	-----	72	-----
	Henry	-----	72	-----
	Highland	-----	72	-----
	Isle of Wight	-----	72	-----
	James City	-----	72	-----
	King and Queen	-----	72	-----
	King George	-----	72	-----
	King William	-----	72	-----
	Lancaster	-----	72	-----
	Lee	-----	72	-----

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,*¹ 1957-75—Con.

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Microctonus colesi</i> ⁶ —				
Continued				
Virginia—				
Continued				
	Loudoun		72	
	Madison		72	
	Mecklenburg		72	
	Middlesex		72	
	Montgomery		72	68
	Nelson		72	
	Newport News		72	
	Norfolk		72	
	Northampton		72, 73	
	Nottoway			70
	Page		72	
	Patrick		72	
	Pittsylvania		72	
	Powhatan		73	
	Prince Edward		72	
	Prince William		72	
	Pulaski		73	
	Richmond		72	
	Roanoke		72	
	Rockbridge		72	73
	Rockingham		72, 73	
	Russell		72, 73	
	Scott		72	
	Shenandoah		72	
	Smyth		72	
	Southampton		72, 73	
	Tazewell		72	
	Warren		72	
	Washington		72	
	Westmoreland		72	
	Wise		72	
West Virginia	Berkeley			73
	Greenbrier			72
	Hardy			72
	Jefferson			70
	Mason			72
	Monongalia			72
	Preston			70
	Putnam			72
Wisconsin	Kenosha	Erly	69	
	do	Pleasant Prairie	69	
Canada (Ontario)	Prince Edward	South Bay	70	
<i>Patasson luna</i>				
Delaware	Kent			73
	New Castle			60
Illinois	Crawford			67
	Hardin			70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
Indiana.....	Harrison.....			72
Maryland.....	Cecil.....			64
	Howard.....			65
	Prince Georges.....			62
Massachusetts.....	Berkshire.....			63
	Hampshire.....			64
New Jersey.....	Burlington.....			61
	Warren.....			62
New York.....	Cayuga.....			71
	Dutchess.....			58
	Livingston.....			73
	Tompkins.....			71
Ohio.....	Clinton.....			73
	Columbiana.....			66
	Erie.....			69
	Franklin.....			73
	Lawrence.....			66
	Mahoning.....			66
	Meigs.....			66
	Wayne.....			69
Pennsylvania.....	Chester.....			62
	Fulton.....			75
	Lancaster.....			64
	Philadelphia.....			64
Virginia.....	Charlotte.....			73
West Virginia.....	Greenbrier.....			71
	Hardy.....			71
	Mason.....			71
	Preston.....			68
Canada (Ontario).....	Carleton.....			70
	Elgin.....			73
	Essex.....			69
	Haldimand.....			73
	Halton.....			73
	Kent.....			73
	Lambton.....			73
	Lincoln.....			73
	Middlesex.....			73
	Oxford.....			73
	Perth.....			73
	Prince Edward.....			72
	Waterloo.....			73
	Welland.....			73
	Wellington.....			71
Canada (Quebec).....	Missisquoi.....			69
<i>Tetrastichus incertus</i>				
Connecticut.....	Tolland.....			64
Delaware.....	Kent.....			64
	New Castle.....			62
	Sussex.....			70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Tetrastichus incertus</i> — Continued				
Illinois.....	Bond.....	Donnellson.....	66	.....
	Champaign.....	St. Joseph.....	67	.....
	.....do.....	Urbana.....	70	.....
	Christian.....	Sicily.....	67	.....
	Coles.....	Fox Ridge State Park	65	.....
	De Witt.....	Kenney.....	68	.....
	Edwards.....	Albion.....	65, 66	.....
	Effingham.....	Watson.....	65	.....
	Fayette.....	Vandalia.....	66	.....
	Fulton.....	Duncan Mills.....	67	.....
	Gallatin.....	Equality.....	66	.....
	Hardin.....	Cave in Rock.....	64	.....
	Jackson.....	Carbondale.....	64	.....
	.....do.....	Grimsby.....	66	.....
	Jasper.....	Ste. Marie.....	65	.....
	Jefferson.....	Texico.....	65	.....
	Johnson.....	Vienna.....	64	.....
	Logan.....	Mt. Pulaski.....	67	.....
	McLean.....	Le Roy.....	67	.....
	Macon.....	Boody.....	67	.....
	Madison.....	Alhambra.....	66	.....
	Mason.....	Havana.....	67	.....
	Massac.....	Mermet.....	64	.....
	Menard.....	Atterberry.....	67	.....
	Piatt.....	Lodge.....	67	.....
	Pike.....	New Hartford.....	67	.....
	Pope.....	Eddyville.....	64	.....
	Pulaski.....	Mounds.....	64	.....
	Randolph.....	Sparta.....	66	.....
	St. Clair.....	Fayetteville.....	66	.....
	Saline.....	Galatia.....	65	.....
	Sangamon.....	Mechanicsburg.....	67	.....
	Scott.....	Winchester.....	67	.....
	Vermilion.....	East Lynn.....	67	.....
	White.....	Brownsville.....	66	.....
Indiana.....	Boone.....	Dove.....	67	.....
	.....do.....	Jamestown.....	67	.....
	Harrison.....	Corydon.....	65, 66	.....
	Jackson.....	Brownstown.....	66	.....
	Johnson.....	Samaria.....	66	.....
	La Porte.....	Wanatah.....	68	.....
	Montgomery.....	Shannondale.....	67	.....
	.....do.....	Smartsburg.....	67	.....
	Ripley.....	Ballstown.....	66	.....
Kansas.....	.....do.....	Osgood.....	66	.....
	Riley.....	Manhattan.....	73	.....
Kentucky.....	Christian.....	Gracey.....	71	.....
	Fayette.....	Lexington.....	71	.....

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Lincoln	(?)	64	-----
	Montgomery	-----	-----	⁴ 65
	Pulaski	(?)	64	-----
	Todd	(?)	64	-----
Maine	Cumberland	-----	69	73
Maryland	Allegany	-----	-----	74
	Anne Arundel	-----	-----	64
	Baltimore	-----	-----	64
	Carroll	-----	-----	64
	Cecil	-----	-----	62
	Frederick	-----	-----	65
	Garrett	-----	-----	74
	Harford	-----	-----	63
	Howard	-----	-----	64
	Kent	-----	-----	65
	Montgomery	-----	-----	64
	Prince Georges	-----	65	65
	Queen Annes	-----	-----	65
	Washington	-----	-----	65
Massachusetts	Berkshire	-----	67	65
	Bristol	-----	64	66
	Essex	-----	-----	66
	Franklin	-----	62	65
	Hampden	-----	-----	65
	Hampshire	-----	62, 67	65
	Middlesex	-----	-----	67
	Norfolk	-----	-----	66
	Plymouth	-----	-----	66
	Worcester	-----	-----	65
Michigan	Branch	-----	68	-----
	Calhoun	-----	68	-----
	Cass	-----	68, 69	-----
	Eaton	-----	68	72
	Hillsdale	-----	68	-----
	Ingham	-----	69	70
	Jackson	-----	68, 69	-----
	Kalamazoo	-----	68	72
	Lenawee	-----	68	-----
	Monroe	-----	68, 69	-----
	St. Joseph	-----	68	73
	Van Buren	-----	68	73
	Washtenaw	-----	68	-----
Missouri	Cape Girardeau	Gordonville	65	-----
	Carter	Fremont	65	-----
	New Madrid	Sikeston	65	-----
	Pemiscot	Steele	65	-----
	Reynolds	Garwood	65	-----
	do	(?)	64	-----
	Stoddard	(?)	64	-----
	Texas	Cabool	71	-----
Nebraska	Dawson	Gothenburg	73	-----

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,*¹ 1957–75—Con.

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Tetrastichus incertus</i> — Continued				
New Hampshire	Cheshire			65
	Grafton			68
	Hillsborough			70
	Merrimack		67	68
	Strafford		67	68
	Sullivan		67	
New Jersey	Burlington		61, 63, 64, 65, 68	63
	Camden		63, 64	64
	Cumberland		64, 65	69
	Gloucester		63	64
	Hunterdon		62, 63	64
	Mercer		62, 63, 64, 65	63
	Middlesex		63, 64, 65	64
	Monmouth		62, 63, 64, 65	64
	Morris		62, 63	63
	Ocean			75
	Salem		63, 64, 65	64
	Somerset		62, 63, 64	64
	Sussex		63	63
	Warren		60, 61, 62, 63	62
New York	Albany			65
	Allegany			66
	Broome			64
	Cattaraugus			66
	Cayuga		65, 68	67
	Chautauqua			66
	Chenango			65
	Clinton			68
	Columbia		63	65
	Cortland			65
	Delaware			64
	Dutchess			65
	Erie			67
	Essex			68
	Franklin			68
	Fulton			66
	Genesee			67
	Greene			65
	Herkimer			67
	Jefferson			67
	Lewis			67
	Livingston			66
	Madison			66
	Monroe			67
	Montgomery		65	66
	Niagara			67
	Oneida		65	67
	Onondaga		65	66
	Ontario			70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Orange			63
	Orleans			67
	Oswego			67
	Otsego			65
	Rensselaer			65
	St. Lawrence			69
	Saratoga			66
	Schenectady		65	68
	Schoharie			67
	Schuyler			65
	Seneca			66
	Steuben			65
	Sullivan			64
	Tioga		64, 65	65
	Tompkins		65	66
	Ulster		68	64
	Warren			66
	Washington			65
	Wayne			67
	Wyoming			66
	Yates			66
North Carolina	Ashe			72
	Buncombe			74
	Haywood			73
	Orange		61	
	Rowan		71	72
	Wake		61, 65, 71	72
Ohio	Allen		72	
	Ashland		67	
	Ashtabula			71
	Brown		71, 72	
	Butler		65, 70	
	Carroll		66	71
	Clark		65	
	Columbiana		66	70
	Coshocton			71
	Crawford		71, 72	
	Darke		72	
	Defiance		72	
	Erie		72	
	Fairfield			73
	Fayette		72	
	Franklin		65, 73	
	Greene		72	
	Guernsey			71
	Harrison		66	
	Huron		67, 72	
	Jefferson			71
	Knox		63	
	Lorain		67	
	Lucas		72	
	Mahoning		65	70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Tetrastichus incertus</i> —				
Continued				
Ohio—				
Continued				
	Medina		65, 67	71
	Meigs		72	
	Mercer		72	
	Muskingum		63	
	Ottawa		72	
	Paulding		72	
	Pickaway		65, 70	
	Preble		72	
	Putnam		72, 73	
	Van Wert		72	
	Warren		72, 73	
	Washington			71
	Wayne		65, 70	70
	Wood		71	
Oklahoma	Stephens	Duncan	72	
Pennsylvania				
	Adams			64
	Bedford			65
	Berks			63
	Blair			65
	Bradford			69
	Bucks			63
	Butler			70
	Cambria			65
	Centre		61	63
	Chester		61	62
	Clarion		62	73
	Clearfield			64
	Clinton			64
	Crawford			67
	Cumberland			70
	Dauphin			64
	Delaware			64
	Erie			64
	Franklin			64
	Fulton			64
	Huntingdon			64
	Jefferson		62	70
	Lancaster			62
	Lebanon			70
	Lehigh			64
	Lycoming			65
	Mercer			67
	Mifflin			64
	Monroe			64
	Montgomery			63
	Montour			69
	Northampton			64
	Northumberland			70

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Perry			64
	Philadelphia			64
	Potter			65
	Schuylkill			64
	Snyder			70
	Somerset			69
	Sullivan			65
	Susquehanna			64
	Tioga			64
	Union			70
	Washington			67
	Westmoreland			70
	York			63
South Carolina	Newberry	Newberry	71	
Tennessee	Blount	Maryville	63	
	Greene	Greeneville	71	
	Knox	Knoxville	71	
	Madison	(?)	63	
	Marshall	Cornersville	71	
	Monroe	Vonore	71	
Texas	Burleson	Snook	71, 72	
	Kaufman	Rosser	71, 72	
	Maverick	Eagle Pass	71, 72	
	Wharton	Cottondale	71	
	do	Iago	72	
	Wilbarger	Vernon	71, 72	
	Zavala	Crystal City	71, 72	
Vermont	Addison		67, 68	70
	Chittenden		66	70
	Franklin			71
	Grand Isle			70
	Windham		65	67
Virginia	Accomack		72	
	Albemarle		72	
	Alleghany		72	
	Amelia		69, 71, 73	70
	Amherst		72	
	Appomattox		72	
	Augusta		72	68
	Bath		72	
	Bedford		72, 73	
	Bland		72	69
	Botetourt		71	66
	Brunswick		71	
	Buchanan		72	
	Buckingham		72	
	Campbell		72	
	Caroline		72	
	Carroll		72	
	Charles City		72	
	Charlotte		71	
	Chesterfield		72	

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Tetrastichus incertus</i> —				
Continued				
Virginia—				
Continued				
	Clarke	-----	72	-----
	Craig	-----	64, 72	-----
	Culpeper	-----	71, 73	-----
	Cumberland	-----	72	-----
	Dickenson	-----	72	-----
	Dinwiddie	-----	71	71
	Fairfax	-----	72	-----
	Fauquier	-----	71	-----
	Floyd	-----	72	-----
	Fluvanna	-----	72	-----
	Franklin	-----	64, 72	-----
	Frederick	-----	72	-----
	Giles	-----	72	66
	Gloucester	-----	72	-----
	Goochland	-----	67, 71	71
	Grayson	-----	72	-----
	Greene	-----	72	-----
	Halifax	-----	71, 72	72
	Hanover	-----	67, 71, 72	68
	Henrico	-----	72	-----
	Henry	-----	61, 72	-----
	Highland	-----	72	67
	Isle of Wight	-----	72	-----
	James City	-----	72	-----
	King and Queen	-----	72	-----
	King George	-----	72	-----
	King William	-----	72	-----
	Lancaster	-----	72	-----
	Lee	-----	72	-----
	Loudoun	-----	72	-----
	Louisa	-----	71	-----
	Lunenburg	-----	71	-----
	Madison	-----	72	-----
	Mecklenburg	-----	72	-----
	Middlesex	-----	72	-----
	Montgomery	-----	61, 72	66
	Nansemond	-----	71	-----
	Nelson	-----	72	-----
	New Kent	-----	69, 71	71
	Newport News	-----	72	-----
	Norfolk	-----	72	-----
	Northampton	-----	72, 73	-----
	Nottoway	-----	71	71
	Orange	-----	71	-----
	Page	-----	72	-----
	Patrick	-----	72	-----
	Pittsylvania	-----	72	-----
	Powhatan	-----	70, 71, 73	71

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
	Prince Edward		72	
	Prince George		71	71
	Prince William		72	
	Pulaski		71, 73	67
	Rappahannock		71	
	Richmond		72	
	Roanoke		72	
	Rockbridge		72	
	Rockingham		72, 73	
	Russell		72, 73	
	Scott		72	
	Shenandoah		72	65
	Smyth		72	
	Southampton		71, 72, 73	
	Spotsylvania		71	
	Stafford		71	
	Tazewell		72	
	Warren		72	
	Washington		72	
	Westmoreland		72	
	Wise		72	
	Wythe		71	
West Virginia	Berkeley			71
	Greenbrier		61	70
	Hardy		71	71
	Jefferson			65
	Mason		71	72
	Mineral			65
	Monroe		61	
	Preston			70
	Roane		64	
Wisconsin	Columbia	Arlington	72	
	do	Lodi	73	
	Iowa	(?)	73	
	Kenosha	Erly	69	
	do	Pleasant Prairie	69	
	Marquette	(?)	73	
	Richland	Gotham	73	
Canada (Ontario)	Brant		70	72
	Bruce			71
	Carleton			70
	Dufferin			71
	Elgin		70	72
	Frontenac			72
	Grenville			72
	Haldimand			72
	Halton			71
	Hastings			72
	Kent		70	72
	Lambton		70	
	Lincoln		70	72
	Middlesex		70	
	Norfolk		70	

See footnotes at end of table.

TABLE 1.—*Species released and recovered in Eastern North America,¹ 1957-75—Con.*

Species released and State	County	Locality	Year of release (19—)	Year of first recovery (19—)
<i>Tetrastichus incertus</i> —				
Continued				
Canada (Ontario)—				
Continued				
	Northumberland	-----		72
	Peel	-----		73
	Prince Edward	-----	70	72
	Waterloo	-----	70	71
	Welland	-----	70	-----
	Wellington	-----		71
	Wentworth	-----		71
Canada (Quebec)	Missisquoi	-----		69

¹ East of longitude 100° W.

² Release and recovery counties for *B. curculionis* are shown on maps 4 and 5. This species is now so widely distributed that it is unnecessary to tabulate release and recovery data.

³ Because recoveries of *B. stenostigma* have been infrequent to date, place localities are shown for all releases.

⁴ Permanent establishment at this locality is in doubt. Subsequent recovery attempts have been negative.

⁵ List includes only releases against alfalfa weevil. During 1948-57, several releases of *M. aethiopoides* were made against *Sitona* spp. in Manitoba, Minnesota, Nebraska, North Dakota, and Washington, but no recoveries are known.

⁶ *M. colesi* was not purposely introduced, but it is probably of foreign origin. See discussion on page 4.

TABLE 2.—*Species released in Eastern North America¹ but not recovered, 1957-75*

Species released and State	County	Locality	Year of release (19—)
<i>Campogaster exigua</i> ²			
Delaware	New Castle	St. Georges	57
New Jersey	Burlington	Moorestown	57
	do	Mount Holly	57
<i>Dibrachoides dynastes</i> ³			
Georgia	Clarke	Athens	62
Illinois	Hardin	Cave in Rock	64
	Johnson	Vienna	64
	Williamson	Creal Springs	64
Maryland	Howard	Clarksville	60
Massachusetts	Franklin	Leverett	62
	Hampshire	Amherst	64
	do	Leverett	62
Missouri	Reynolds	(?)	64
	Stoddard	(?)	64
New Jersey	Burlington	Moorestown	64
	do	Mount Holly	59, 60, 63
	do	Rancocas	59, 60
	Hunterdon	Flemington	62
	do	Ringoes	60

See footnotes at end of table.

TABLE 2.—*Species released in Eastern North America¹ but not recovered, 1957-75*
—Continued

Species released and State	County	Locality	Year of release (19—)
	Mercer.....	Pennington.....	62
	Somerset.....	Belle-Mead.....	62
	Warren.....	Blairstown.....	60, 61, 62
	.....do.....	Johnsonburg.....	61
New York.....	Tioga.....	Nichols.....	64
North Carolina.....	Wake.....	Raleigh.....	63
Pennsylvania.....	Centre.....	State College.....	61
	Lancaster.....	Christiana.....	64
Virginia.....	Craig.....	Newcastle.....	61
	Franklin.....	Wirtz.....	61
West Virginia.....	Greenbrier.....	(?).....	61
	Monongalia.....	(?).....	61
	Monroe.....	(?).....	61
<i>Microctonus stelleri</i>			
Delaware.....	New Castle.....	Newark.....	69
	Sussex.....	Overbrook.....	69
Illinois.....	Champaign.....	Urbana.....	69
	Douglas.....	Kemp.....	68
	Wayne.....	Fairfield.....	68
Kentucky.....	Ballard.....	Kevil.....	69
	Fayette.....	Lexington.....	69
Maryland.....	Frederick.....	Frederick.....	68
Massachusetts.....	Hampshire.....	Northampton.....	68
Michigan.....	Berrien.....	Three Oaks.....	69
	Cass.....	Howard T.....	68
	.....do.....	Pokagon.....	69
New Jersey.....	Burlington.....	Rancocas.....	60
	Salem.....	Alloway.....	69
	Sussex.....	Hamburg.....	68
New York.....	Ulster.....	New Paltz.....	68
Pennsylvania.....	Franklin.....	Sylvan.....	69
	Northampton.....	Martins Creek.....	69
	York.....	Dillsburg.....	68
Vermont.....	Addison.....	Shoreham.....	68
Virginia.....	Augusta.....	Steeles Tavern.....	68
	Charlotte.....	Charlotte C.H.....	69
Wisconsin.....	Rock.....	Beloit.....	70
<i>Necremnus leucarthros</i>			
New Jersey.....	Burlington.....	Deacons.....	65
	Mercer.....	Pennington.....	65
<i>Peridesmia discus</i>			
Alabama.....	Morgan.....	Decatur.....	70
Arkansas.....	Craighead.....	Monette.....	67
	Mississippi.....	Blytheville.....	67
	.....do.....	Keiser.....	66
	.....do.....	Yarbro.....	67
Delaware.....	Kent.....	Dover.....	59, 60
	.....do.....	Smyrna.....	59
	New Castle.....	Middletown.....	59
Georgia.....	Clarke.....	Athens.....	71
	Fulton.....	Roswell.....	71, 72
	Oconee.....	Bogart.....	72

See footnotes at end of table.

TABLE 2.—*Species released in Eastern North America*¹ but not recovered, 1957–75
—Continued

Species released and State	County	Locality	Year of release (19—)
<i>Peridesmia discus</i> — Continued			
Illinois.....	Hardin.....	Cave in Rock.....	70
Kentucky.....	Fayette.....	Lexington.....	72
Maryland.....	Howard.....	Clarksville.....	60
New Jersey.....	Burlington.....	Columbus.....	59
	do.....	Medford.....	59
	do.....	Mount Holly.....	60
North Carolina.....	Rowan.....	Salisbury.....	66
	Wake.....	Raleigh.....	66, 67
	do.....	Wake Forest.....	67
Oklahoma.....	Stephens.....	Duncan.....	72
Pennsylvania.....	Chester.....	Oxford.....	61
South Carolina.....	Greenwood.....	Ninety Six.....	72
	Oconee.....	Clemson.....	72
Tennessee.....	Cumberland.....	Crossville.....	72
	Knox.....	Knoxville.....	67
	Marshall.....	Lewisburg.....	66
	Mauzy.....	Spring Hill.....	66
	Sullivan.....	Blountville.....	72
Texas.....	Burleson.....	Snook.....	71, 72
	Kaufman.....	Rosser.....	72
	Maverick.....	Eagle Pass.....	72
	do.....	Quemado.....	71
	Wharton.....	Boling.....	71
	do.....	Iago.....	72
	Wilbarger.....	Vernon.....	72
	Zavala.....	Crystal City.....	71, 72
Virginia.....	Accomack.....	Onancock.....	59
	Charlotte.....	Red Oak.....	72
	Montgomery.....	Blacksburg.....	72
	Rockbridge.....	Steeles Tavern.....	72
<i>Trichomalus inops</i>			
Alabama.....	Morgan.....	Decatur.....	70
Arkansas.....	Mississippi.....	Keiser.....	67
Delaware.....	Kent.....	Dover.....	59, 60
	do.....	Smyrna.....	59
	New Castle.....	Middletown.....	59
Illinois.....	Hardin.....	Cave in Rock.....	70
New Jersey.....	Burlington.....	Columbus.....	59
	do.....	Mount Holly.....	60
Virginia.....	Accomack.....	Onancock.....	59

¹ East of longitude 100° W.² List includes only releases against alfalfa weevil. During 1948–57, several releases of *C. exigua* were made against *Sitona* spp. in Manitoba, Minnesota, Nebraska, North Dakota, and Washington, but no recoveries are known.³ Although *D. dynastes* has never been recovered in the East, it is known to be established in California.

APPENDIX

TABLE 3.—*Partial list of species released in the Western States¹ and their origin, 1957-75*

[Includes only parasite material supplied through USDA sources]

Species released, State, and county		Locality	Year of release (19—)	Origin
<i>Bathyplectes anurus</i>				
California	Alameda	Albany	67	N.J.
	Glenn	Orland	67	N.J.
	Riverside	Lakeview	67	N.J.
Colorado	Garfield	New Castle	75	Pa.
	Larimer	Ft. Collins	75	Pa.
	Mesa	Fruita	75	Pa.
	do	Palisade	71, 73, 74, 75	N.J., Pa.
Idaho	Latah	Moscow	69	N.J., Pa.
Montana	Ravalli	(?)	71	Pa.
Nevada	Churchill	Fallon	71	Pa.
	Washoe	Reno	71	Pa.
New Mexico	Valencia	Los Lunas	75	Pa.
Oklahoma	Texas	Guymon	74	Pa.
Oregon	Benton	Corvallis	74, 75	Pa.
	Grant	Dayville	72	N.J., Pa.
	Linn	Corvallis	72	N.J., Pa.
South Dakota	Lawrence	Spearfish ²	71, 72	N.J., Pa.
Utah	Cache	Logan	72	N.J., Pa.
Washington	Clallam	(?)	71	Pa.
Wyoming	Fremont	Riverton	71	Pa.
	Platte	Wheatland	73	N.J.
<i>Bathyplectes stenostigma</i>				
California	Alameda	Albany	69	Sweden.
Colorado	Mesa	Collbran ³	69	Do.
	do	Fruita ³	69	Do.
Utah	Cache	North Logan	69	Do.
<i>Dibrachoides dynastes</i>				
Colorado	Mesa	(?)	64	France.
<i>Microctonus aethiopoides</i>				
Arizona	Maricopa	Phoenix	65	N.J.
	do	Tempe	65	N.J.
	Yuma	Yuma	65	N.J.
California	Riverside	Crestmore	68	N.J.
	Siskiyou	(?)	66	N.J.
Colorado	Mesa	Clifton	65	N.J.
	do	Collbran	73	N.J.
	do	Grand Junction	67, 69	N.J.
	do	Palisade	72	N.J.
	Montezuma	Dolores	73	N.J.
	do	Lewis	73	N.J.

See footnotes at end of table.

TABLE 3.—*Partial list of species released in the Western States¹ and their origin, 1957-75—Continued*

Species released, State, and county		Locality	Year of release (19—)	Origin
<i>Microctonus aethiopoides</i> — Continued				
Idaho	Bingham	Aberdeen	66	N.J.
	Latah	Juliaetta	69	N.J.
	do	Moscow	66	N.J.
	Twin Falls	Twin Falls	66	N.J.
Montana	Ravalli	(?)	71	Pa.
Nevada	Washoe	Reno	71	N.J.
New Mexico	Valencia	Belen	75	Pa.
Oregon	Benton	Corvallis	72, 73, 74	N.J., Pa.
	Linn	do	73	N.J.
South Dakota	Lawrence	Spearfish	69, 71, 72	N.J.
Utah	Cache	Logan	67, 72	N.J.
	do	North Logan	69	N.J.
Wyoming	Fremont	Morton	71	N.J.
	do	Riverton	71	N.J.
	Platte	Wheatland	72	N.J.
<i>Microctonus colesi</i>				
California	Alameda	Albany	69	N.J.
	Riverside	La Sierra	68	N.J.
	Siskiyou	Dorris	67	N.J.
	do	Yreka	70	N.J., Pa.
Colorado	Mesa	Grand Junction	69	N.J.
Idaho	Latah	Juliaetta	69	N.J.
<i>Microctonus stelleri</i>				
Colorado	Mesa	Clifton	66	France.
	do	Palisade	69	Do.
<i>Peridesmia discus</i>				
Arizona	Maricopa	Tempe	67	Do.
California	Monterey	Gonzales	72	Do.
Nevada	Churchill	Fallon	72	Do.
Oregon	Linn	Corvallis	72	Do.
<i>Tetrastichus incertus</i>				
Arizona	Maricopa	Phoenix	66	N.J.
	do	Tempe	65, 66	N.J.
	Yuma	Yuma	65, 66	N.J.
California	Monterey	(?)	63	France.
	Riverside	Hemet	65	N.J., Pa.
	do	Lakeview	64	France, N.J., Pa.
	do	La Sierra	65	N.J., Pa.
	do	Riverside	64, 65	France, N.J., Pa.
	do	(?)	66	N.J.
	San Diego	San Pasqual	64, 65	France, N.J., Pa.
	do	(?)	66	N.J.
	Siskiyou	(?)	63, 66	France, N.J.

See footnotes at end of table.

TABLE 3.—*Partial list of species released in the Western States¹ and their origin, 1957-75—Continued*

Species released, State, and county		Locality	Year of release (19—)	Origin
Colorado	Delta	(?)	64	N.J.
	Garfield	New Castle	64	N.J.
	do	Rifle	64	N.J.
	Larimer	Ft. Collins	65	N.J., Pa.
	do	Kelim	66	N.J., Pa.
	do	Timnath	65	N.J., Pa.
	Mesa	De Beque	64	N.J.
	do	Fruita	65, 71	N.J., Pa.
	do	Grand Junction	69	N.J.
	do	Loma	65	N.J., Pa.
	do	Palisade	64	N.J.
	Montrose	(?)	64	N.J.
	Weld	Berthoud	66	N.J., Pa.
	do	Gilcrest	65	N.J., Pa.
	do	Greeley	65	N.J., Pa.
	do	Johnstown	66	N.J., Pa.
Idaho	Bingham	Aberdeen	65, 69	N.J., Pa.
	Canyon	Caldwell	64	N.J., Pa.
	Caribou	Grace	65	N.J., Pa.
	Latah	Juliaetta	69	N.J.
	do	Moscow	64, 66	N.J., Pa.
Nevada	Twin Falls	Twin Falls	65	N.J., Pa.
	Washoe	Reno	71	France.
Oregon	Linn	Corvallis	73	N.J., Sweden.
South Dakota	Lawrence	Spearfish	69	N.J., Pa.
Utah	Cache	Logan	67	N.J.
	Salt Lake	Draper	67	N.J.
	do	Salt Lake City	67	N.J.
Washington	Whitman	Pullman	64	N.J.
Wyoming	Platte	Wheatland	73	N.J., Sweden.

¹ West of longitude 100° W.² Recovered during 1973.³ Recovered during 1971 and 1975.

Note.—Many other parasite colonies have been liberated in the West. Since California has had an active parasite introduction program against *Hypera postica* and *H. brunneipennis* for many years, the California reports and publications should be consulted for a complete record.

PATASSON LUNA

RECOVERIES (TABLE 1)

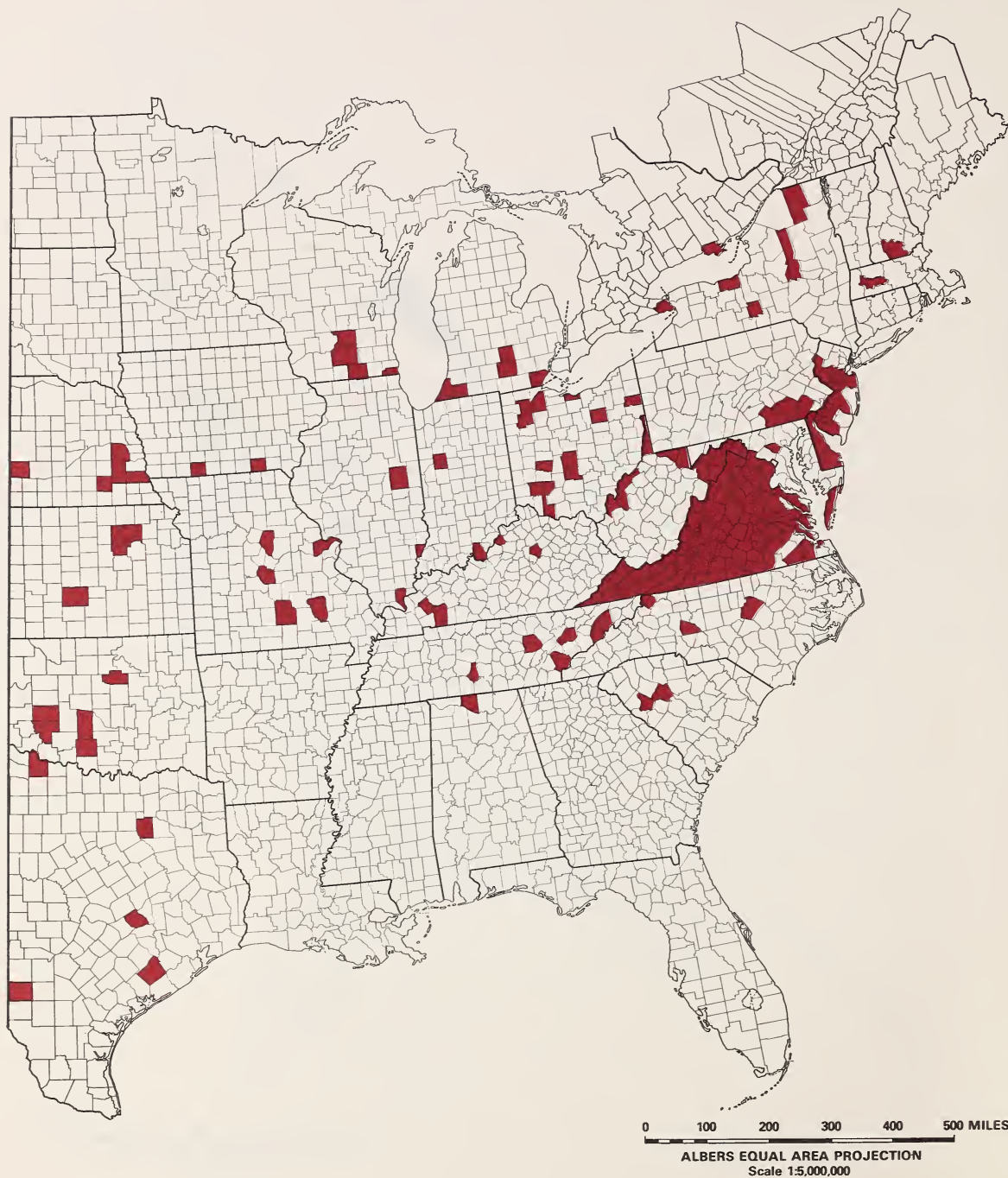
MAP 1



BATHYPLECTES ANURUS

RELEASES (TABLE 1)

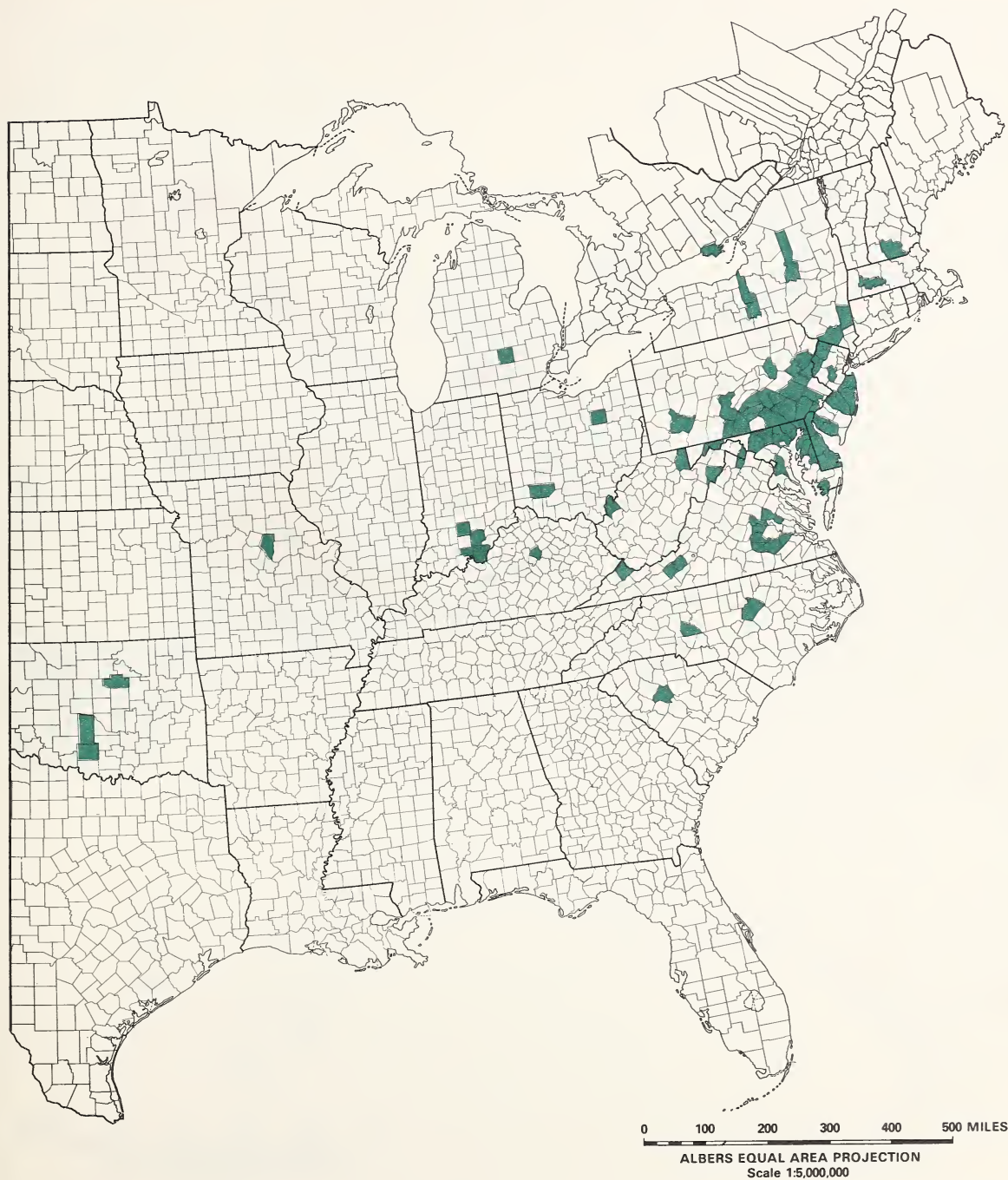
MAP 2



BATHYPLECTES ANURUS

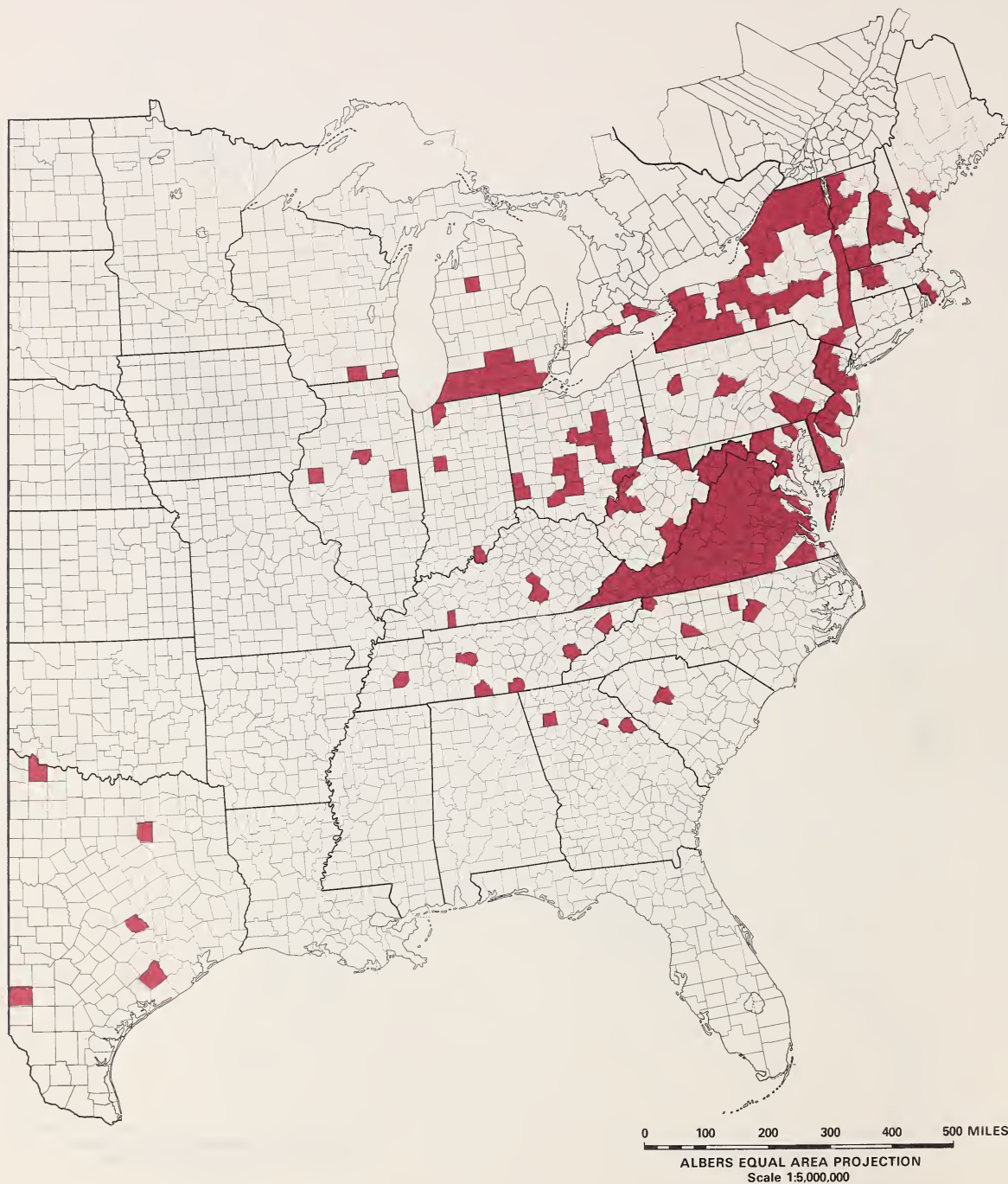
RECOVERIES (TABLE 1)

MAP 3



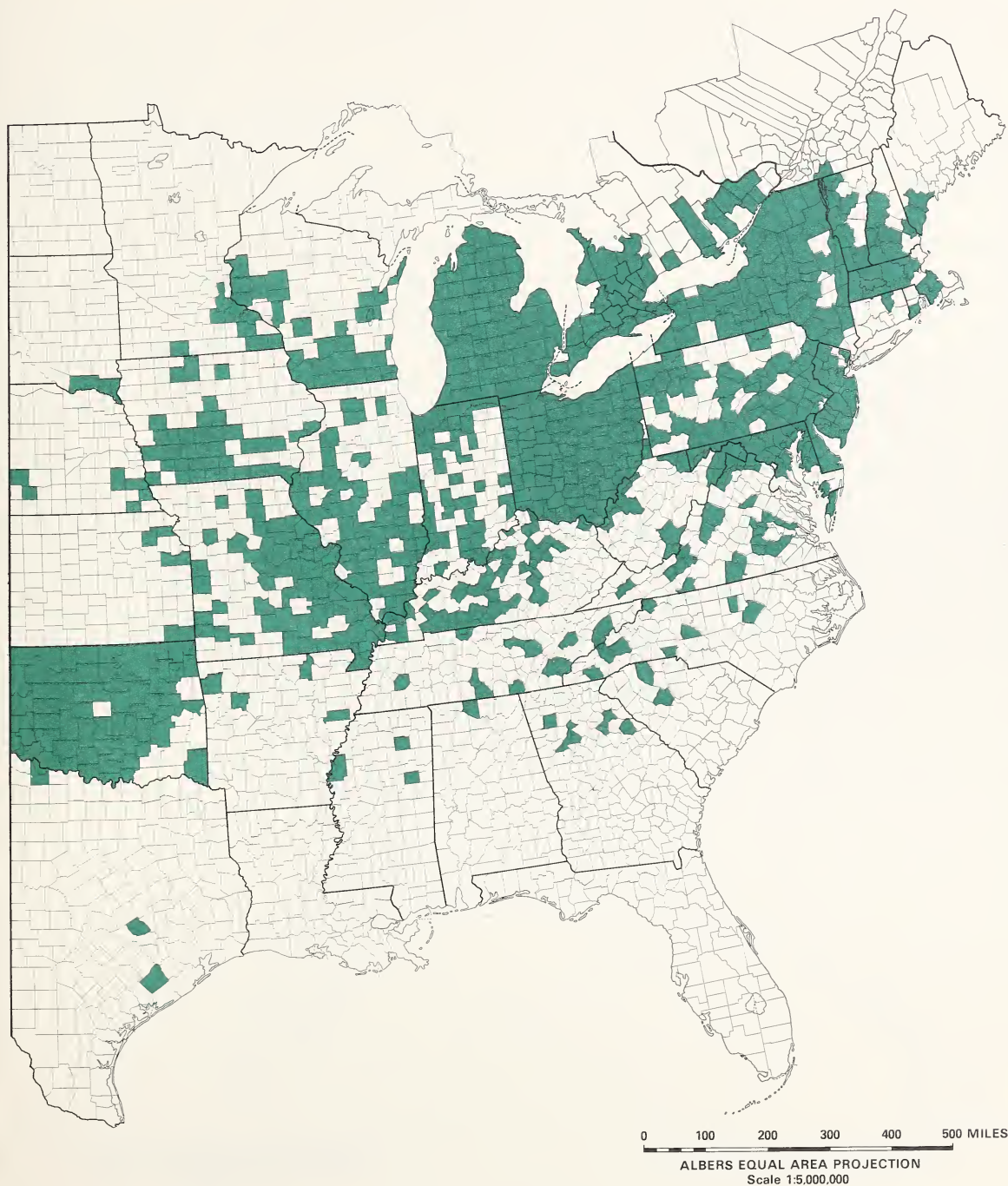
BATHYPLECTES CURCULIONIS RELEASES

MAP 4



BATHYPLECTES CURCULIONIS RECOVERIES

MAP 5



BATHYPLECTES STENOSTIGMA

RELEASES (TABLE 1)

MAP 6



0 100 200 300 400 500 MILES

ALBERS EQUAL AREA PROJECTION
Scale 1:5,000,000

BATHYPLECTES STENOSTIGMA

RECOVERIES (TABLE 1)

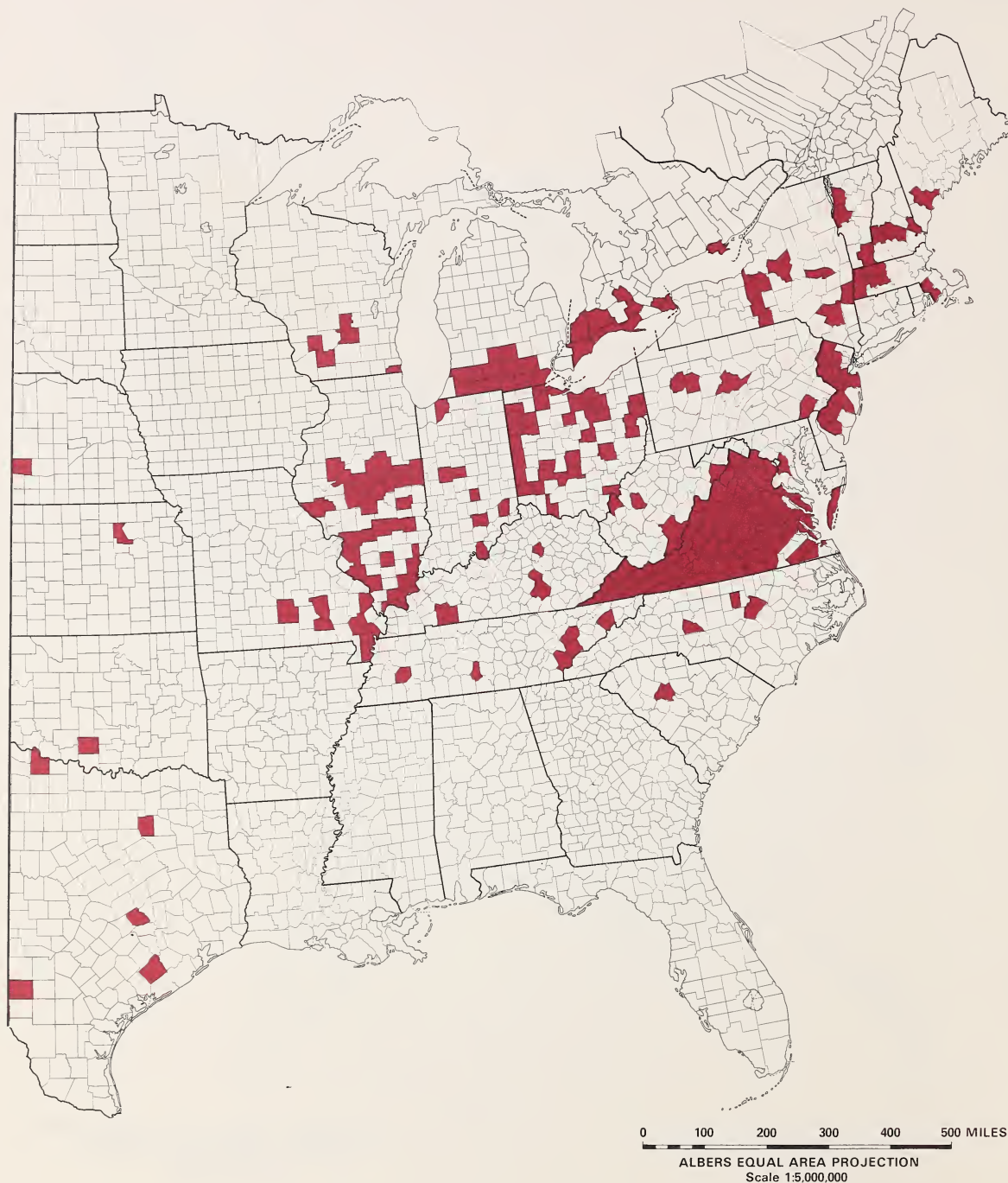
MAP 7



TETRASTICHUS INCERTUS

RELEASES (TABLE 1)

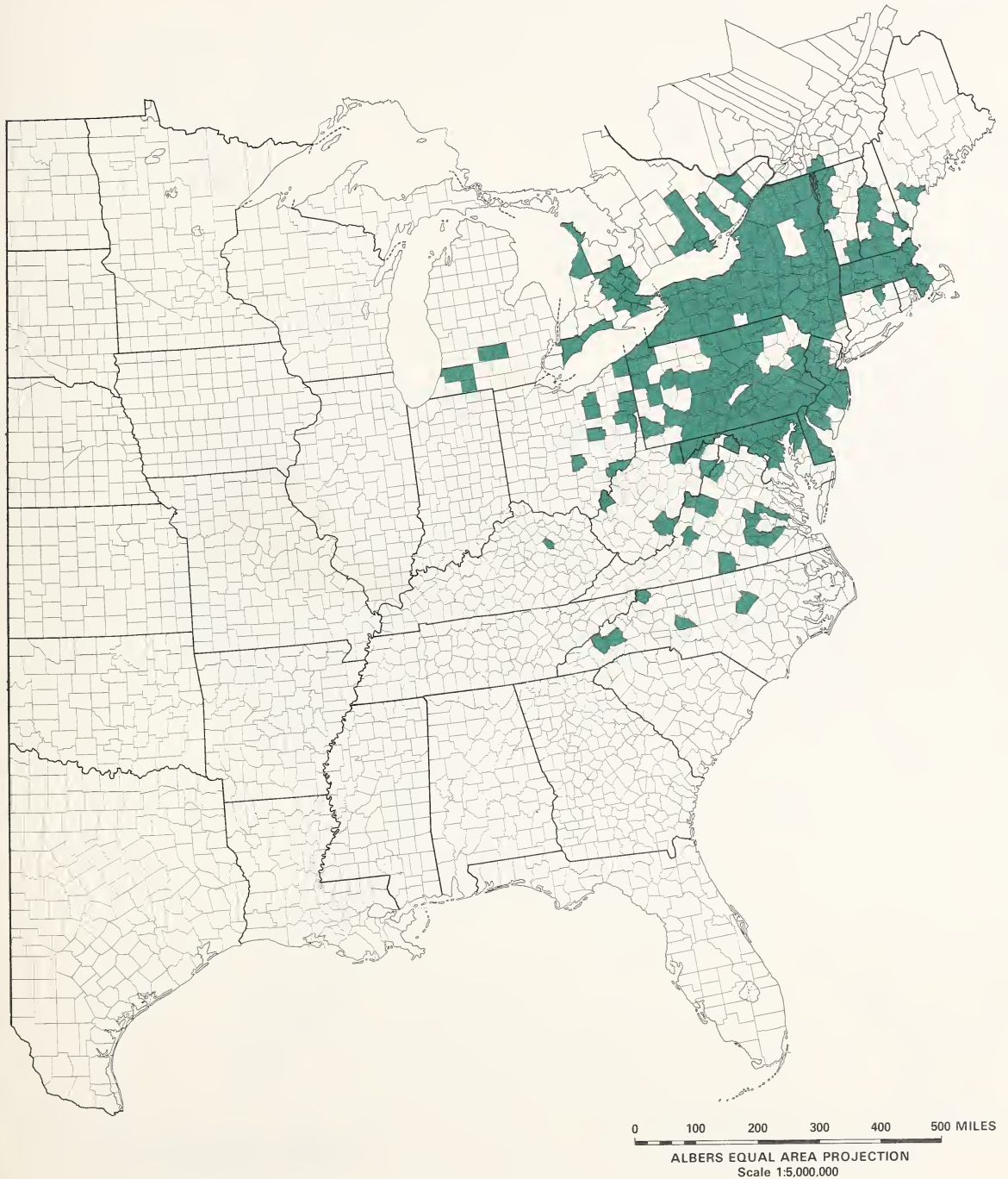
MAP 8



TETRASTICHUS INCERTUS

RECOVERIES (TABLE 1)

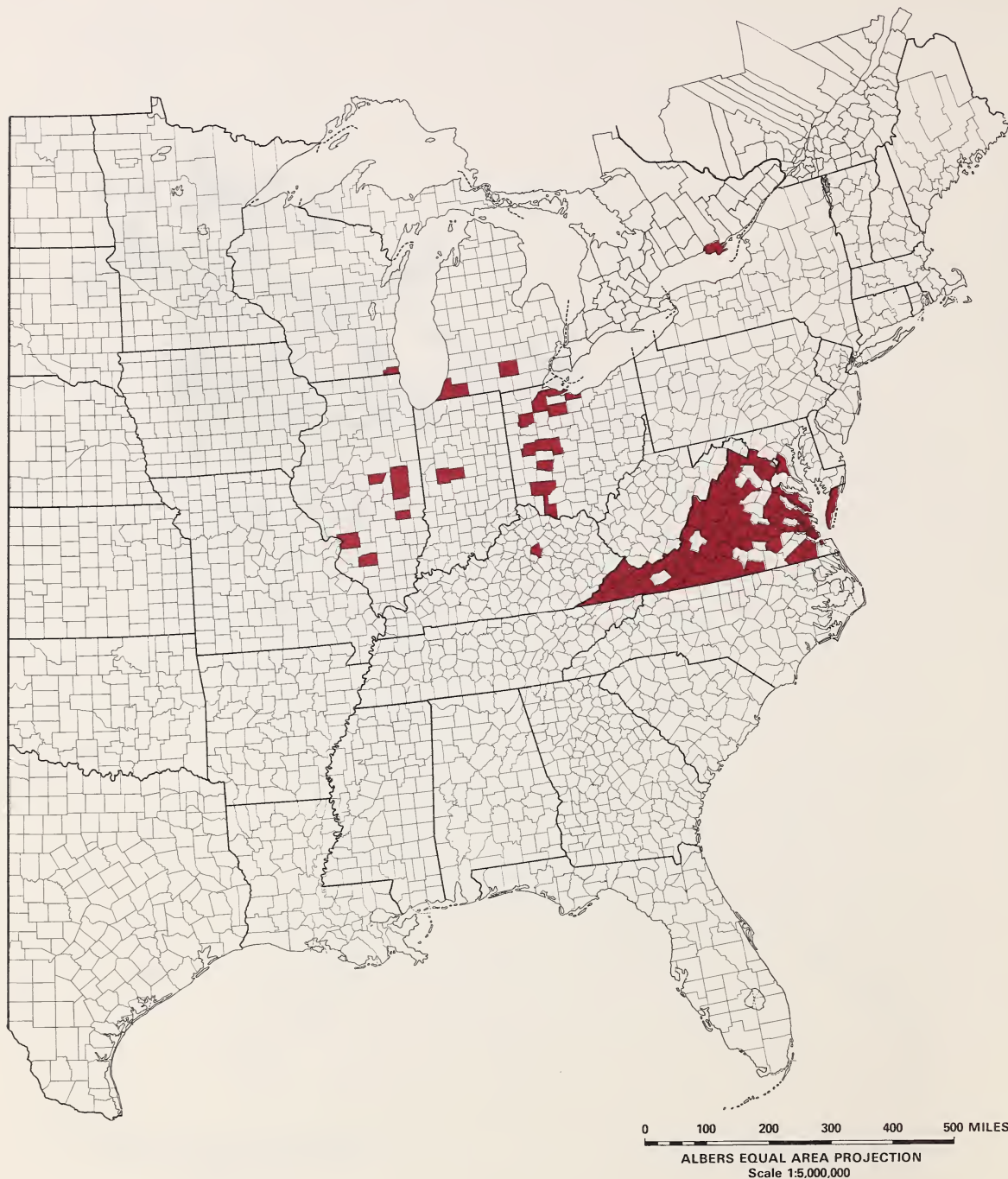
MAP 9



MICROCTONUS COLESI

RELEASES (TABLE 1)

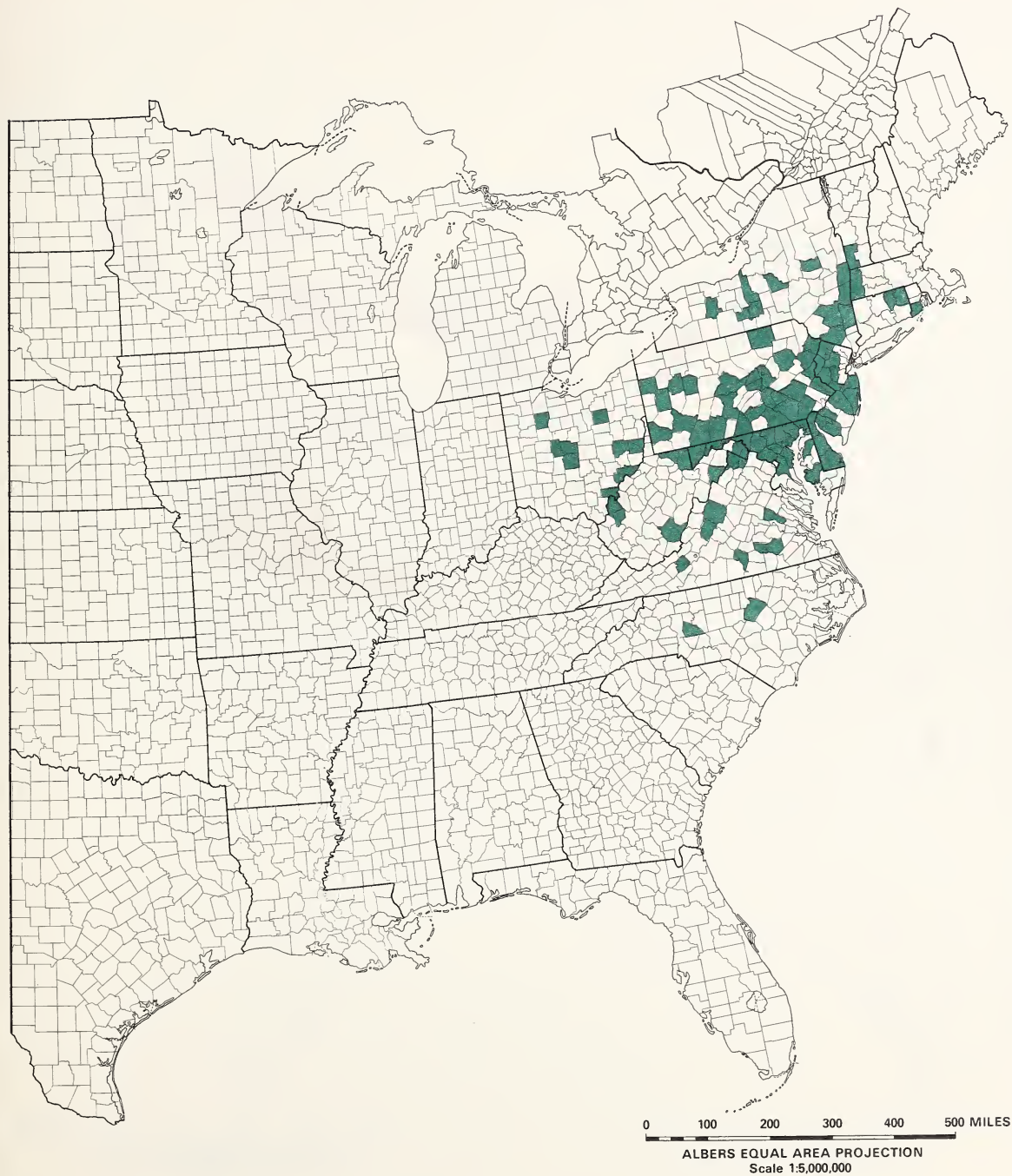
MAP 10



MICROCTONUS COLESI

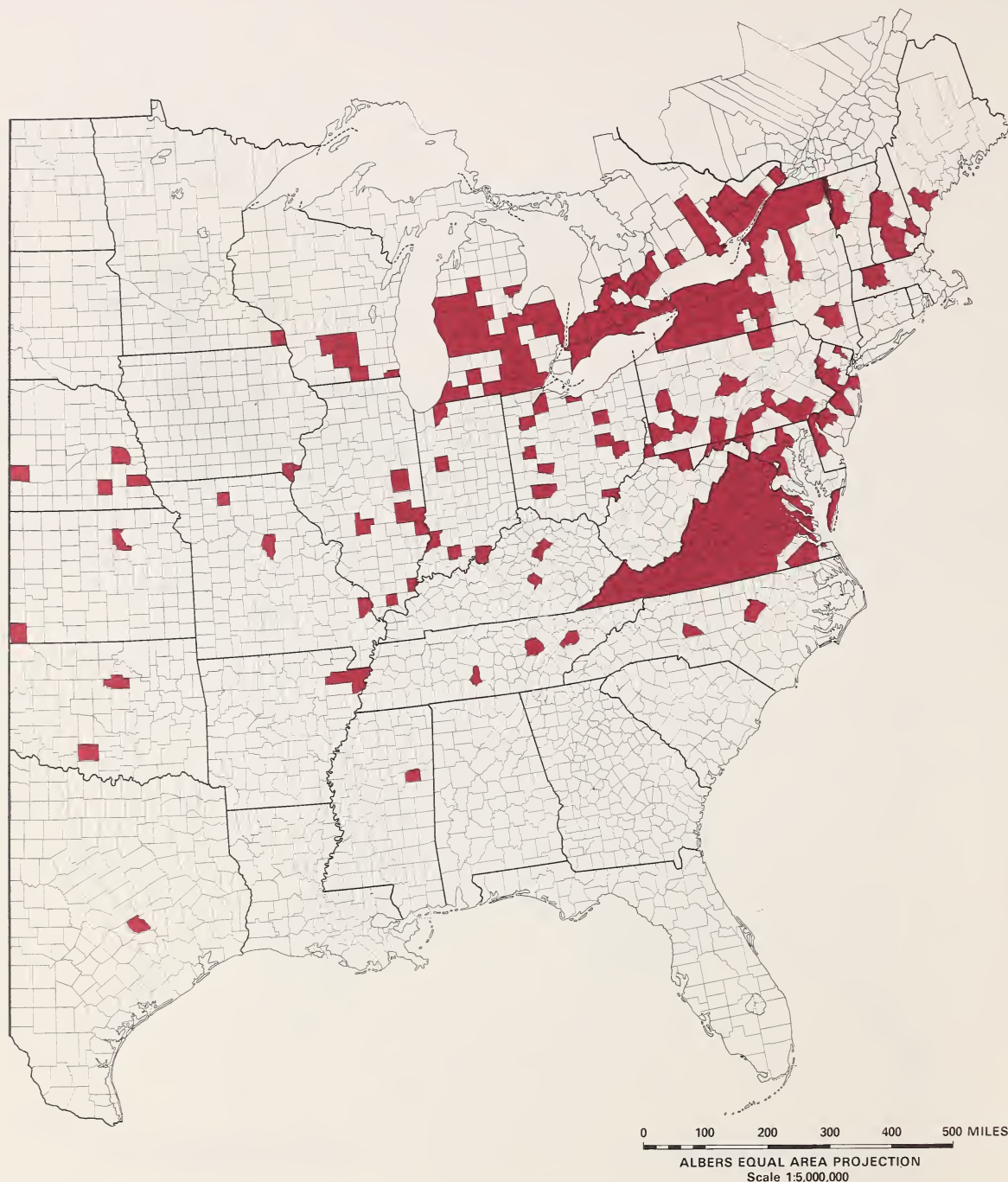
RECOVERIES (TABLE 1)

MAP 11



MICROCTONUS AETHIOPOIDES RELEASES (TABLE 1)

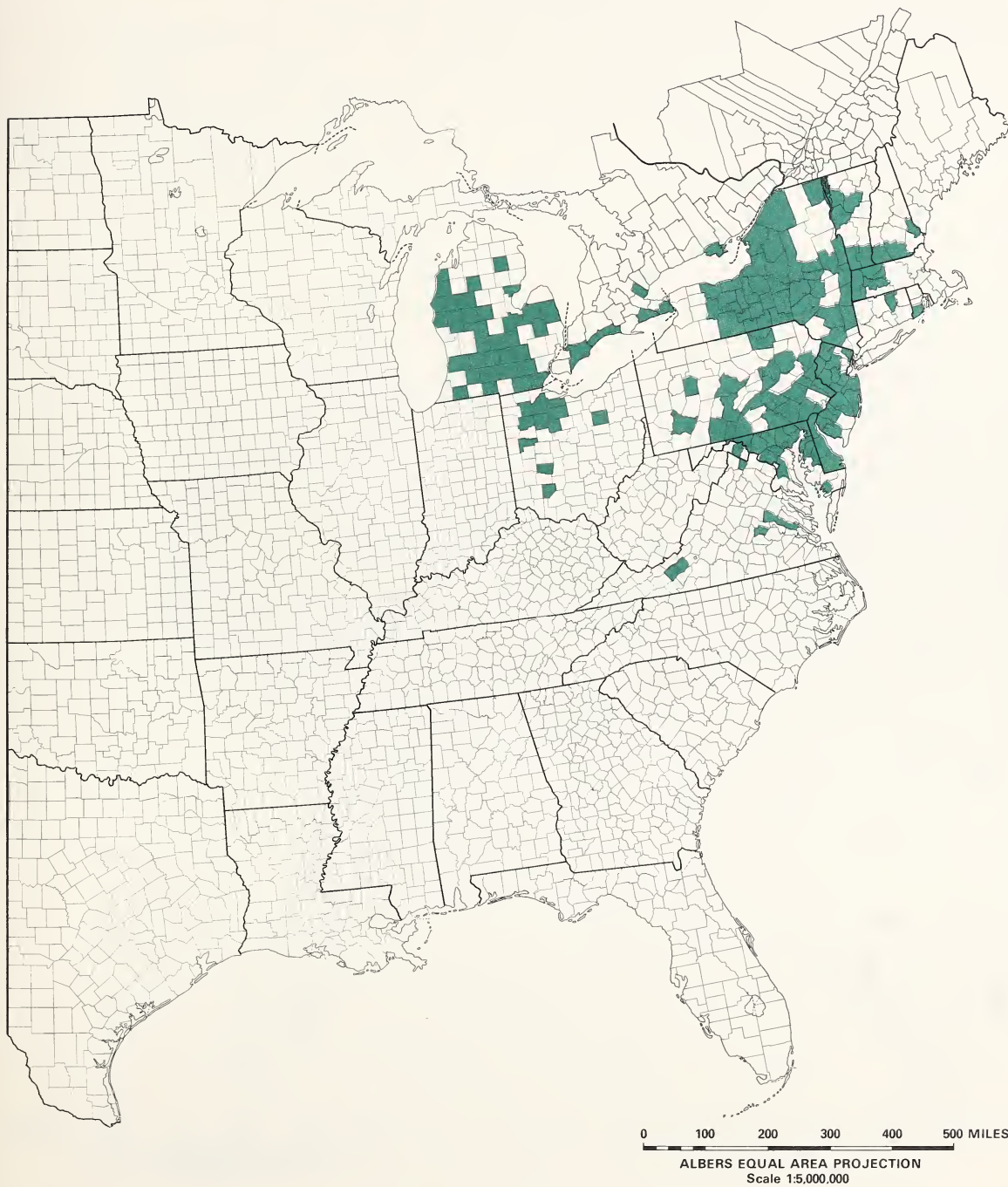
MAP 12



MICROCTONUS AETHIOPOIDES

RECOVERIES (TABLE 1)

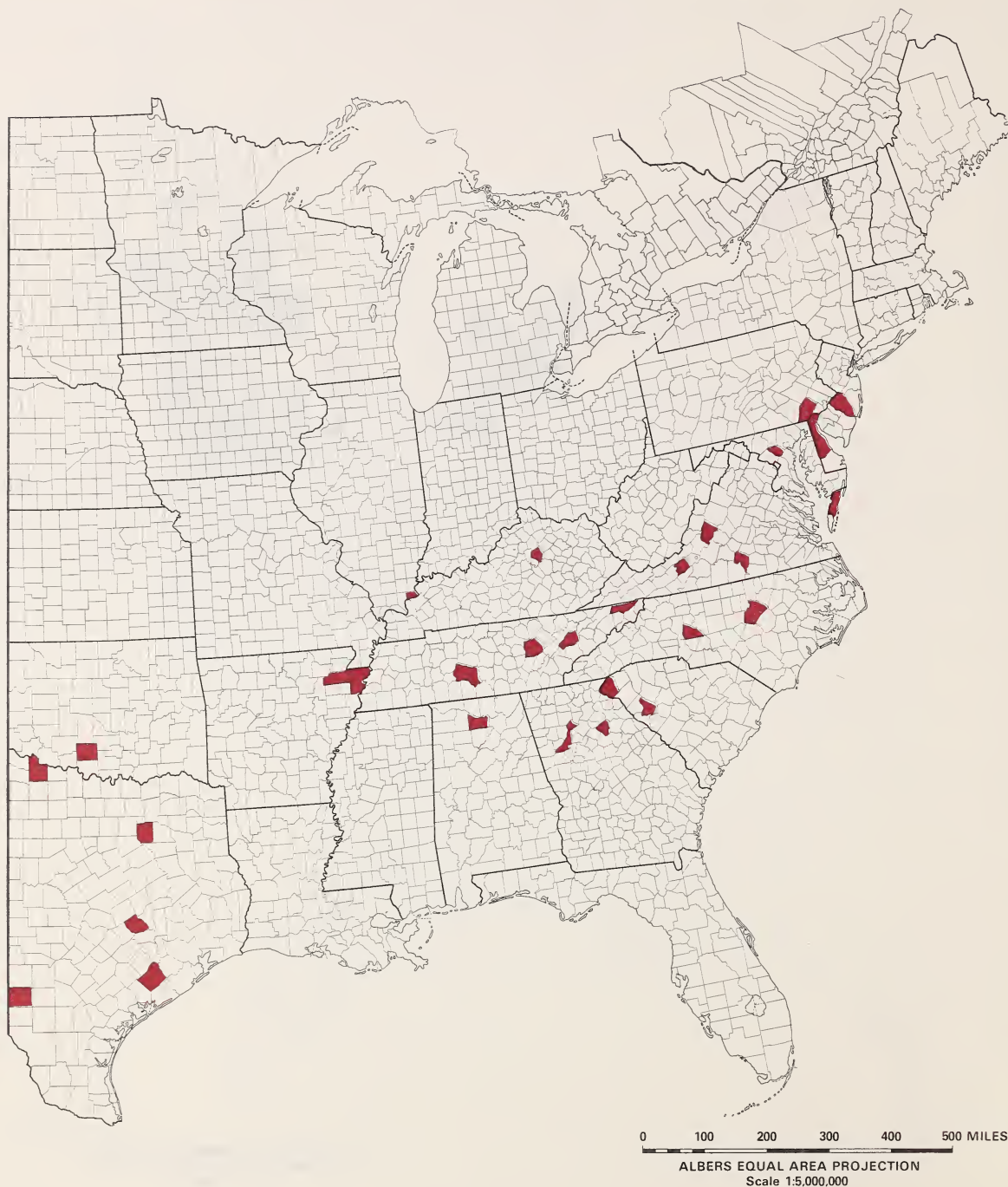
MAP 13



PERIDESMIA DISCUS

RELEASES (TABLE 2)

MAP 14



RELEASES (TABLE 2)

MAP 15



DIBRACHOIDES DYNASTES

RELEASES (TABLE 2)

MAP 16



NECREMNUS LEUCARTHROS

RELEASES (TABLE 2)

MAP 17



CAMPOGASTER EXIGUA

RELEASES (TABLE 2)

MAP 18



0 100 200 300 400 500 MILES

ALBERS EQUAL AREA PROJECTION
Scale 1:5,000,000

MICROCTONUS STELLERI

RELEASES (TABLE 2)

MAP 19



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